

21 August 1980

MILITARY SPECIFICATION

TANK, STORAGE, LIQUID OXYGEN, LOW
LOSS CLOSED CYCLE, TMU-70/M

This specification is approved for use by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for one type of a trailer mounted 50 gallon tank for storage and servicing of aircraft liquid oxygen converters.

2. APPLICABLE DOCUMENTS

2.1 Issue of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

O-T-236	-Tetrachloroethylene (Perchloroethylene), Technical Grade.
O-T-634	-Trichloroethylene, Technical.
BB-N-411	-Nitrogen, Technical.
UU-T-81	-Tags, Shipping and Stock.
PPP-T-60	-Tape, Packaging, Waterproof.

MILITARY

MIL-P-116	-Preservation - Packaging, Methods of.
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Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, ESSD, Code 93, Lakehurst, NJ 08733 by using the self-addressed Standard Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 3655

MILITARY (continued)

MIL-R-3065	-Rubber, Fabricated Parts.
MIL-I-6866	-Inspection, Penetrant Method Of.
MIL-I-6868	-Inspection Process, Magnetic Particle.
MIL-W-8005	-Wheels and Hubs, For Industrial Pneumatic Tires.
MIL-M-8090	-Mobility, Towed Aerospace Ground Equipment, General Requirements For.
MLL-A-8421	-Air Transportability Requirements, General Specification For.
MIL-P-23377	-Primer Coating, Epoxy Polyamide, Chemical and Solvent Resistant.
MIL-O-27210	-Oxygen, Aviator's Breathing Liquid and Gas.
MIL-T-27730	-Tape, Antiseize, Tetrafluoroethylene, With Dispenser.
MIL-C-81302	-Cleaning Compound, Solvent, Trichlorotrifluoroethane.
MIL-C-81773	-Coating, Polyurethane, Aliphatic, Weather Resistant.

STANDARDS

MILITARY

MIL-STD-105	-Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	-Marking for Shipment and Storage.
MIL-STD-130	-Identification Marking of U.S. Military Property.
MIL-STD-143	-Standards and Specifications, Order of Precedence for the Selection of.
MIL-STD-470	-Maintainability Program Requirements (For Systems and Equipments).
MIL-STD-471	-Maintainability Demonstration.
MIL-STD-810	-Environmental Test Methods for Aerospace and Ground Equipment.
MIL-STD-831	-Test Reports, Preparation of.
MIL-STD-838	-Lubrication of Military Equipment.
MIL-STD-889	-Dissimilar Metals.
MIL-STD-1186	-Cushioning, Anchoring, Bracing, Blocking and Waterproofing, With Appropriate Test Methods.
MIL-STD-1595	-Aerospace Welder Performance Qualification.

FEDERAL

FED-STD-595	-Colors.
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DRAWINGS

NAVAL AIR SYSTEMS COMMAND

1212AS140	-Coupling Assembly.
1212AS141	-Coupling, Male.
1212AS142	-Gasket, Coupling.

AIR FORCE

48B7796

-Ring Assembly - Tie Down, 10,000 Pounds,

(Copies of specifications, standards, drawings and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Section VIII

-Boiler and Pressure Vessel Code.

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.)

CONSOLIDATED CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Consolidated Classification Committees 202 Chicago Union Station, Chicago, IL 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), the contractor shall furnish sample unit(s) for first article inspection and approval (see 4.3).

3.2 Selection of specifications and standards. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143.

3.3 Components. The tank shall "consist of the following major components:

- a. Storage tank assembly.
- b. Transfer tank assembly.
- c. Control housing assembly.
- d. Chassis.

3.4 Materials. Materials shall conform to applicable specifications and as specified herein. Materials which are not covered by applicable specifications or which are not specifically described herein shall be of the best quality, of the lightest practicable weight and suitable for the purpose intended.

3.4.1 Metal parts. Whenever practicable, lightweight metals shall be used in the construction of the tank. All metal parts shall be of a corrosion resistant material or treated in a manner to render them adequately resistant to corrosion.

3.4.1.1 Chilled surfaces. All metallic surfaces of the tank and components thereof that contact high-purity oxygen or that are in a location where they will be chilled sufficiently during operation to cause condensation of moisture from the atmosphere shall be fabricated from corrosion-resistant materials that require no paint or other organic chemical coatings to protect them from corrosion.

3.4.1.2 Dissimilar metals. Dissimilar metals, such as defined by MIL-STD-889, shall not be used in intimate contact with each other unless suitably protected against electrolytic corrosion with protective coatings.

3.4.2 Nonmetallic materials. Any nonmetallic material that is adversely affected by continued use with oxygen shall not be used.

3.4.2.1 Gasketing and insulating materials. Gasketing and insulating materials shall be suitable for their intended application and, where applicable, resistant to hydrocarbons or low temperatures. Polytetrafluoroethylene gasketing material for other than the liquid fill coupling gasket shall be impregnated with not less than 25 percent pulverized glass fiber to improve its dimensional stability under compression.

3.4.2.2 Elastomers. All elastomer components, such as door seals, et cetera, shall be fabricated from rubber compounds conforming to MIL-R-3065 in order to insure their resistance to ozone attack.

3.4.2.2.1 Age. Elastomer components, except silicone, shall be not more than 12 months old from the date of manufacture to the date of delivery to any Government service or to any manufacturer.

3.4.3 Combustible materials. Readily combustible materials shall not be used.

3.5 Standard parts. MS and AN standard parts shall be used where they suit the purpose. The types and sizes of hardware, such as bolts, screws, nuts, et cetera, and fastening devices shall be kept to a minimum.

3.6 Design. The tank shall be a complete, self-contained, liquid oxygen transport., storage and servicing unit including all parts, controls, instruments and accessories, designed for:

- a. Being filled with liquid oxygen at a supply location.
- b. Being air transported while filled with liquid oxygen and pressurized to 40 pounds per square inch gage (psig).
- c. Transporting the liquid oxygen.
- d. Storing the liquid oxygen with low evaporation loss rates.
- e. Servicing the aircraft liquid oxygen converters by transferring the liquid from the storage tank to the transfer tank and then into the converter. The transfer tank shall operate independent of the storage tank and the vented oxygen gas from the converter shall be returned to the storage tank during the servicing operation.

3.6.1 Configuration. The tank configuration shall be that of a two-wheeled trailer with a steerable swing-up-type retractable landing gear. The tank and its landing gear shall be designed to meet the requirements of MIL-M-8090 as specified for type II, group A mobility, except the minimum ground clearance shall be 6.5 inches. The latch or pin used to retain the landing gear in position shall be fabricated from corrosion-resistant material.

3.6.2 Schematic diagram. Figure 1 is a schematic diagram of the tank lines, valves, relief devices and instruments. The piping is shown on both ends for illustration purposes only. The actual tank design has all components located on one end of the tank.

3.6.3 Reliability. The tank shall have a reliability (probability of - successful operation) of not less than 0.96 at 0.87 confidence (see 6.3.1).

3.6.4 Maintainability. Parts and assemblies shall be located and mounted to provide adequate clearance for repair and other maintenance and, where practicable, to permit removal and replacement of any part or assembly by removing or disconnecting only mounting bolts or fasteners, panel doors, tubing, or control cables to the part or assembly being removed. The equipment shall be designed and constructed in accordance with the design guidelines of MIL-STD-470, paragraph titled Establish Maintainability Design Criteria, except rather than being merely considered, the guidelines shall be applied wherever appropriate to the subject class or type of equipment and wherever they do not conflict with other requirements specified herein. Where practicable, the design and construction of the tank shall permit maintenance and servicing under adverse weather extremes.

3.6.4.1 Operating clearance. To the maximum practicable extent, maintainability provisions shall incorporate features insuring operating clearance for facilitating maintenance and servicing at low ambient temperatures by personnel wearing heavy gloves or mittens and handicapped by bulky clothing and footwear.

"1.6.4.2 Intricate devices. intricate locking devices, controls, and threaded fastenings that can be easily overtorqued by personnel lacking feel through thick gloves or numbness shall be avoided where possible.

3.6.4.3 Cover and plate fasteners. Covers and plates that must be removed for component adjustments or for component or part removal shall be equipped with substantial quick-disconnect fastenings.

3.6.4.4 Maintenance down-time. The equipment shall be designed and constructed to permit maintenance by military service maintenance technicians in not more than the specified down-time. Not more than two technicians shall be required simultaneously for any task.

3.6.4.4.1 Corrective maintenance down-time. The mean corrective maintenance down-time for all levels of maintainance below depot maintenance shall be not more than 45 minutes with a related maximum corrective maintenance down-time of not more than 2 hours.

3.6.4.4.2 Maximum preventive maintenance down-time. Maximum preventive maintenance down-time, excluding depot maintenance and major overhaul, shall be not more than 2 hours at the 0.9 percentile point.

3.6.5 Capacity.

3.6.5.1 Storage tank. The storage tank shall store not less than 50 U.S. gallons of liquid oxygen conforming to MIL-O-27210, type II at its atmospheric pressure boiling temperature. The liquid storage tank assembly shall have an internal volume of not less than 55 U.S. gallons in order to provide an expansion (vapor) space of not less than 10 percent of the total design capacity.

3.6.5.2 Transfer tank. The transfer tank shall store not less than 15 liters of liquid oxygen at its atmospheric pressure boiling temperature. The transfer tank assembly shall have an internal volume of not less than 16.5 liters in order to provide an expansion (vapor) space of not less than 10 percent of the total design capacity.

3.6.6 Storage attitude. The tank shall be capable of being stored in a tilted position (towbar end down) regardless of the level of fill with the front wheel retracted. A protective bumper shall be provided, if required, to prevent damage to any component of the tank which may result from repeated dropping of the towbar end while the tank is resting on the two main wheels.

3.6.7 Hoisting and tiedown attachment devices. Tiedown devices for compliance with MIL-A-8421 shall be provided. These shall include four or more tie-down ring assemblies conforming to drawing 4837796. The tiedown devices shall serve for both tiedown and hoisting, and shall permit hoisting

of the complete assembled tank filled to design capacity with liquid oxygen, considering vertical accelerations of 3 gravitational units (g). The rings shall be so located on the tank that transportation personnel can easily rig safe slings from common cable and spreader bar components for hoisting by a single-hook overhead crane and maintaining a level attitude.

3.6.8 Liquid loss. The tank shall be designed to insure the minimum practicable loss of oxygen during cool-down, pressure building, et cetera.

3.6.9 Servicing converter. Wherever practicable, the tank shall be designed to permit rapid converter removal and replacements. Disconnect points shall be clearly indicated and identified.

3.6.10 Protective covers. All cover plates, gaskets and fittings necessary for protection of contained apparatus during operating, storage and shipment of the tank shall be provided.

3.6.11 Lubricants. The tank shall be designed to fully comply with the requirements specified herein when components needing lubrication are serviced with military or federal specification lubricants in accordance with MIL-STD-838,

3.6.12 Cold weather operation. The tank shall be designed for full operational use in any ambient (see 6.3.3) temperature between -65° and +125°F without special provisions for winterization.

3.7 Construction. The tank shall be constructed to withstand the strains, shocks, vibrations and other conditions incident to operation, maintenance, shipping and storage with minimum loss of service time for maintenance, repair and periodic servicing.

3.7.1 Foolproofness. Where improper installation of an item could cause malfunctioning of that item or the system in which it is installed, an unsymmetrical mounting means shall be provided. This mounting shall be so designed that the item can only be installed in its proper operating position.

3.7.2 Component mounting. Components that need not be removed or repositioned for use shall be securely mounted to the liquid storage tank assembly or other major components in a manner that shall insure against damage or unnecessary movement during operation and transport. All sub-bases and other fixtures needed for safe and secure component mounting shall be provided and installed.

3.7.3 Tubing and lines. Tubing and lines shall be located in protected positions, securely fastened to frame or body structures, and provided with metal protective loop or grommets at each point where they pass through members, except where a through--the-frame connector is provided.

3.7.4 Pressure vessels. Unless otherwise specified herein, the liquid storage tank assembly, piping, and connections thereto shall be fabricated in accordance with section VIII of the ASME Boiler and Pressure Vessel Code.

3.7.5 Location of controls and gages. All controls and gages shall be located on end opposite to the swing up type retractable landing gear. Controls, gages and instruments shall be installed in locations where they will not be contacted by liquid oxygen leaking from lines or connections and where water cannot drip on them as a result of vapor condensing on cold lines. In addition, controls and gages necessary for operating the storage tank functions shall be separated from controls and gages necessary for operating the transfer tank.

3.7.6 Parts fabrication. Sheet-metal parts shall be of such thickness, rigidity and strength as to withstand dents, warping, vibration, radiated heat, et cetera, encountered in service and maintenance and under the conditions specified herein.

3.7.7 Locking devices. Where practicable, all screws, pins, bolts, et cetera, shall be equipped with locking devices. Safety wire, self-locking nuts, cotter pins, lock-washers, et cetera, will be acceptable. Where practicable, lockwashers shall be secured to bolts or screws. Cotter pins shall be fabricated from corrosion-resistant steel.

3.7.8 Thread sealer. Tape conforming to MIL-T-27730 or other pipe thread sealing materials specifically approved by the procuring activity shall be applied to threads, prior to assembly of all pipe threaded fittings subject to contact by liquid or gaseous oxygen. The tape shall be applied, starting with the third thread, to prevent contaminating the system.

3.7.9 Cleaning solvent drains. Provisions shall be included to insure that cleaning solvent and flushing liquids can be readily and thoroughly removed from the liquid storage tank assembly, from the pressure build-up system and from the associated tank piping and components following cleaning operations.

3.7.10 Pressure relief devices. Pressure relief devices shall be provided in any line or component that can be so isolated by closing valves, or otherwise, that dangerous pressures could develop. All pressure relief devices shall be installed at readily accessible locations. Provisions shall be incorporated to insure discharge of pressure without damage to equipment or danger to personnel. Safety valves shall be sized and selected in accordance with section VIII of the ASME Boiler and Pressure Vessel Code.

3.7.11 Special operation and maintenance tools. When specified (see 6.2), a complete set of all special tools, other than common hand-tools and tools normally available in motor vehicle repair shops, required for proper operation and maintenance of the tank and its components shall be provided.

3.7.12 Certification of welders. All welding shall be accomplished by welders certified in accordance with MIL-STD-1595, class A.

3.8 Performance.

3.8.1 Spring-loaded relief valve test. The spring-loaded relief valve, when tested as specified in 4.6.2, shall open and reseal within the specified limits of the relief valve and shall show no evidence of leakage.

3.8.2 Pressure test. The tank and each component and circuit of the tank, when tested as specified in 4.6.3, shall not show any evidence of leaks or material failure.

3.8.3 Cleanliness test.

3.8.3.1 Particulate matter test. The liquid sample from the tank, when tested as specified in 4.6.4.1, shall not contain the following:

- a. Any solid particle with a dimension greater than 1,000 microns.
- b. Any fibrous particle with a length greater than 6,000 microns.
- c. Any more than 25 mg total of both solid and fibrous particles.

3.8.3.2 Total solids test. The tank, when tested as specified in 4.6.4.2, shall not show a filter weight increase of more than 0.1 gram.

3.8.4 Storage capacity. The tank, when tested as specified in 4.6.5, shall store not less than 50 U.S. gallons of liquid oxygen conforming to MIL-O-27210, type II at its atmospheric pressure boiling temperature and shall have an internal volume of not less than 55 U.S. gallons.

3.8.5 Air transportability. The tank, when tested as specified in 4.6.6, shall not show any evidence of material failure, loosening or loss of parts or of threaded, riveted or other type fasteners; damage to or loss of calibration in gages and other instruments; or loss of vacuum in the annular space attributable to either outgassing or leaks.

3.8.6 Vacuum retention test. The tank, when tested as specified in 4.6.7, shall not show any indications of frosting, cold spots, or leakage. The tank shall not have suffered any fracture of piping, braces, brackets

or of a welded, brazed, or soldered connection); loosening or loss of threaded, riveted or other fasteners; or gages and other instruments damaged or out of calibration as a result of the vibration.

3.8.7 Heat leak evaporation loss rate test.

3.8.7.1 First article test. The storage tank heat leak evaporation loss, when tested as specified in 4.6.8.1, shall not exceed the equivalent of 10 pounds of oxygen per 24 hours.

3.8.7.2 Quality conformance test. The storage tank heat leak evaporation loss, when tested as specified in 4.6.8.2, shall not exceed the limit established during the first article test.

3.8.8 Pressure build-up test.

3.8.8.1 Build-up with low liquid level. The vapor phase pressure of the storage tank, when tested as specified in 4.6.9.1, shall stabilize at 50 psig.

3.8.8.2 Transfer tank pressure build-up. The time required to attain the build-up pressure of 90 psig, when tested as specified in 4.6.9.2, shall not exceed 2 minutes.

3.8.9 Insulation combustibility. The insulation, when tested as specified in 4.6.10, shall not show a sudden temperature rise, charring of the insulation material, or other evidence of ignition or burning.

3.8.10 Liquid transfer test,

3.8.10.1 Fill-drain line test. The fill-drain line pressure drop, when tested as specified in 4.6.11.1, shall not exceed 3 psig.

3.8.10.2 Converter servicing time. The time required to fill a 10 liter converter, when tested as specified in 4.6.11.2, shall not exceed 5 minutes.

3.8.10.3 Vent line test. The tank, when tested as specified in 4.6.11.3, shall cool down in not more than 15 minutes and the inner shell vapor pressure shall not exceed 15 psig.

3.8.10.4 Vapor relief capacity. The vapor space pressure of the storage tank, when tested as specified in 4.6.11.4, shall not exceed 65 psig.

3.8.11 Filter tests.

3.8.11.1 Absolute rating. The filter bubble point pressure, when determined as specified in 4.6.12.1, shall be not less than 6 inches of water. The bubble point pressure shall be the pressure at which the first bubble is emitted from the filter element.

3.8.11.2 Nominal rating. The filter, when tested as specified in 4.6.12.2, shall not have a weight increase of more than 0.2 gram.

3.8.11.3 Filter pressure drop. The filter, when tested as specified in 4.6.12.3, shall have a pressure drop not greater than 2 psig and shall not show permanent distortion or damage to the filter element and housing as a result of the 50 psig pressure drop across the filter element.

3.8.12 Shut-off and control valve test. The valve, when tested as specified in 4.6.13, shall show no evidence of damage or improper operation and the total gas leakage shall not exceed 2 cubic inches per hour per inch of valve nominal size.

3.8.13 Disconnect coupling torque resistance test. The fill-drain line disconnect coupling fitting, when tested as specified in 4.6.14, shall show no evidence of material failure such as; twisting of, distortion of, or damage to tank or connections.

3.8.14 Servicing and maintenance test. All normal preventive maintenance and servicing operations for the tank, when tested as specified in 4.6.15, shall be performed without any interference or obstruction.

3.8.15 Mobility test. The tank, when tested as specified in 4.6.16, shall have proper weight distribution, stopping adequacy and shall show no evidence of material failure.

3.8.16 Environmental tests. The tank, when subjected to the environmental tests specified in 4.6.17, shall show no evidence of any mechanical or material failure and the time for the pressure build-up system shall not exceed 2 minutes during the low temperature test.

3.8.17 Servicing test. The tank, when tested as specified in 4.6.18, shall operate satisfactorily without requiring any servicing or maintenance.

3.8.18 Mechanical check. The tank shall pass the requirements specified in 4.6.19, when subjected to the mechanical test.

3.8.19 Reliability demonstration. The tank shall pass the requirements specified in 4.6.20, when subjected to a reliability demonstration.

3.8.20 Maintainability demonstration. The tank shall pass the requirements specified in 4.6.21, when subjected to a maintainability demonstration.

3.8.21 Bursting disc. When tested as specified in 4.6.22, the bursting disc shall rupture at 75 psig \pm 10 percent for the storage tank and 125 psig \pm 10 percent for the transfer tank.

3.9 Details of components.

3.9.1 Liquid storage tank and transfer tank assemblies.

3.9. 1.1 Liquid storage tank and transfer tank assembly components. The liquid storage tank and transfer tank assemblies shall consist of the following:

- a. Inner shell.
- b. Outer shell.
- c. Inner shell suspension system.
- d. Insulation.
- e. Piping and connections.
- f. Safety devices.
- g. Controls.
- h. Pressure build-up system.
- i. Instruments.

3.9.1.2 Fabrication. The liquid storage tank assembly shall be a welded vessel designed and fabricated in accordance with section VIII of the ASME Boiler and Pressure Vessel Code to contain, and retard evaporation loss of, liquid oxygen as necessary to insure compliance with the performance requirements. In addition, the inner shell shall be certified under the code for the specified working pressure. The transfer tank assembly shall be a double-walled Dewar designed and fabricated in accordance with section VIII of the ASME Boiler and Pressure Code and shall be permanently attached to the storage tank. The transfer tank shall be capable of being gravity filled from the storage tank and shall operate independently of the storage tank after being filled from the storage tank.

3.9.1.2.1 Component arrangement. The liquid storage tank shall be fabricated with the inner shell suspended within the outer shell to maintain a vacuum-tight annular insulation space of sufficient distance between corresponding points on the shells and heads to meet the requirements specified herein.

3.9.1.2.2 Dissimilar metal vacuum joints. Any dissimilar metal vacuum joints (see 6.3.6) used in the tank construction shall not show any leakage rate increase when tested as specified in 4.6.6.2.1.

3.9.1.3 Inner shell. The inner shell shall physically store the liquid oxygen. Insofar as practicable, it shall be designed to have the minimum surface area consistent with the requirements specified herein. The inner shell shall have a smooth inside bottom surface exclusive of joggles or backup rings throughout an arc of not less than 6 inches on each side of the vertical centerline for the entire length of the inner shell to insure complete drainage with the liquid fill-drain line.

3.9. 1.3.1 Inner shell attachments. The inner shell shall be equipped with all parts, fittings, attachments, and accessories necessary to provide for support, liquid transfer, total draining, venting, safety and determining of liquid level.

3.9.1 .3.2 Inner shell material. The inner shell shall be fabricated from stainless steel material with sufficient strength, rigidity and vacuum-holding properties to insure compliance with the requirements specified herein.

3.9.1.3.3 Inner shell design pressure. The storage tank inner shell shall be designed and constructed for a maximum working pressure of 50 psig while recovering vented gases from the converter unit during the transfer operation. The inner shell of the transfer tank shall be designed and constructed for a maximum working pressure of 90 psig for transferring and servicing liquid oxygen converters under the conditions specified herein. Design and construction shall also be such as to insure against:

- a. Distortion or damage when the liquid storage tank assembly annular insulation space is evacuated to a high vacuum and is pressurized to the outer shell pressure relief device maximum opening pressure, and,
- b. Collapse of or damage to the inner shell when it is evacuated to an absolute pressure of 100 microns mercury (Hg) or less with the annular insulation space at atmospheric pressure.

3.9.1.4 Outer shell. The outer shell shall provide support for the inner shell and inner shell suspension system. The underside of the outer shell shall be reinforced as necessary to comply with the requirements specified herein.

3.9.1.4.1 Outer shell material. The outer shell shall be fabricated from material having sufficient strength, rigidity and vacuum-holding properties to insure compliance with the requirements specified herein.

3.9.1.4.1.1 Outer shell sections. The outer shell sections, through which piping connections to the inner shell pass, shall be fabricated from material resistant to corrosion caused by contact with oxygen, nitrogen, moist air, salt atmosphere, or water, to protect against corrosion in case the protective coating is damaged by the extreme changes in temperature that it must undergo on and adjacent to the lines carrying liquid and cold vapors. Corrosion-resistant, low thermal conductive sleeves may be used to thermally isolate the liquid and vapor-carrying lines from the outer shell.

3.9.1.4.2 Design pressure. The outer shell shall be designed and constructed for a working pressure that shall insure sufficient strength and rigidity to prevent distortion or damage when the annular insulation space is evacuated to a high vacuum.

3.9. 1.4.3 Vacuum. The outer shell shall be provided with a vacuum fitting designed for effective evacuation of the annular insulation space.

3.9.1.4.3.1 Vacuum pump-out and relief assembly. The vacuum pump-out and relief assembly shall serve as the vacuum pump-out and outer shell safety relief device.

3.9.1.4.3.2 Vacuum line filter. A vacuum filter shall be provided so that no insulation could be drawn into the vacuum pump, if used. The filter shall present the minimum practicable restriction to gas flow consistent with effectively preventing insulation passing from the annular space into the vacuum pump line.

3.9.1.5 Inner shell suspension system. The liquid storage tank assembly inner shell shall be supported and positioned within the outer shell by a suspension system that will thermally isolate the inner shell from the outer shell and provide an annular insulation space.

3.9.1.5.1 Strength. The inner shell suspension system shall be of sufficient strength and rigidity to solidly support and prevent damage to or unnecessary movement of the inner shell when it is filled to design capacity with liquid oxygen and subjected to the air transportability test.

3.9.1.5.2 Heat transfer resistance. The inner shell suspension system shall be fabricated from material possessing the maximum practical resistance to heat flow, and shall provide the minimum practicable heat transfer area between the liquid storage tank assembly inner and outer shells without sacrifice of necessary strength and rigidity.

3.9.1.6 Annular space insulation. The annular insulation space shall contain an insulation that will, together with evacuation of the annular space, minimize heat transfer. The insulating material shall be of a composition that shall not ignite or burn when heated to 400°F in 99.5 percent pure oxygen gas at a pressure of not less than 10 psig. Application of the insulation shall be such as to insure against settling or displacement in service.

3.9.1.6.1 Getter material. If a getter material is utilized in the annular space, it shall be secured in direct thermal contact with the inner shell. In addition, the getter material shall be of a type capable of being reactivated during evacuation at the temperature generated by the purging unit (220 F on the inner tank shell).

3.9.1.7 Piping -and connections.

3.9.1.7.1 Intertank piping connections. Piping and connections between the inner and outer shells shall be held to the minimum necessary for insuring safety and performance in accordance with the requirements specified herein. Connecting piping shall be of corrosion-resistant material possessing the maximum practicable resistance to heat flow and shall be installed to provide the maximum practicable length of heat transfer path combined with the minimum practicable heat transfer area.

3.9.1.7.1.) Liquid lines. A single internal fill-drain and service line shall be provided. Externally the line shall be connected to provide separate liquid fill-drain and liquid service lines, valves, filters, and disconnects.

3.9.1.7.1.1.1 Liquid fill-drain line. The liquid fill-drain line shall be sized and installed to provide for liquid oxygen flow or transfer into or out of the inner shell at a rate of not less than 10 gpm without the pressure drop through the line and filter exceeding 3 psig. The line shall terminate outside the control housing assembly in a 1 inch external pipe thread for installation of the disconnect coupling.

3.9.1.7.1.1.1.1 Liquid fill-drain line installation. The liquid fill-drain line shall be connected to the bottom of the inner shell in a manner which will insure complete drainage of the inner shell into the line. In addition, the liquid fill-drain line installation shall be such as to:

- a. Insure against liquid entering from the inner shell when all liquid shut-off valves are closed and the tank is tilted up to and including 10 degrees about the lateral or longitudinal axis.
- b. Insure that the inner shell can be completely gravity drained through the liquid fill-drain line without pressurization when the tank is tilted not more than 20 about the wheel axis.
- c. Minimize heat transfer between the inner and outer shells, and
- d. Expose the least practicable length of line outside the outer shell.

3.9.1.7.1.1.1.2 Liquid fill-drain line shut-off valve. A manually operated shut-off valve, having a free passage size approximately equal to that of the liquid fill-drain line inner diameter when fully open, shall be provided in the line as near as practicable to the point where it enters the outer shell. The valve shall be so located and installed that liquid flow to the pressure build-up coil will not be restricted. General design and construction shall be as specified in 3.9.1.10.1 through 3.9.1.10.1.3.

3.9.1.7.1.1.1.2.1 Liquid fill-drain line shut-off valve mounting. The liquid fill-drain line shut-off valve shall be solidly mounted in a location readily accessible to an operator standing on the ground in front of the control panel. The valve shall be so mounted to supporting members that force applied in opening or closing the valve will not damage the tank piping or connection. Mounting of the valve to supporting members shall be accomplished with material possessing the maximum practicable resistance to heat flow to reduce, to a minimum, evaporation of liquid, filled into the tank through the fill-drain line.

3.9.1.7.1.1.1.3 Liquid fill-drain line disconnect coupling. A 1 inch, male, liquid oxygen coupling assembly conforming to drawings 1212AS140, 1212AS141 and 1212AS142 shall be assembled and installed on the liquid fill-drain line external pipe threads.

3.9.1.7.1.1.1.3.1 Liquid fill-drain line disconnect coupling mounting. The disconnect coupling shall be solidly mounted as near as practicable to the fill-drain line shut-off valve in a location readily accessible to an operator standing on the ground outside the tank control housing assembly. The mounting location shall provide sufficient clearance around the coupling for use of strap wrenches or other tools to assist in installation or removal of the coupling, or attachment and uncoupling of liquid transfer hoses. The disconnect coupling shall be so mounted to supporting structures or members that a torque of 300 pound feet (lb ft) per inch of nominal line size applied to the coupling in either direction of rotation with a 24 inch wrench will not damage tank piping or connections. Mounting of the disconnect coupling to supporting members shall be accomplished with material possessing considerable resistance to heat flow, to reduce to a minimum, evaporation of liquid, filled into the tank through the liquid fill-drain line. The coupling shall be located at the control end of the unit and shall be compatible with shipboard filling equipment.

3.9.1.7.1.1.1.4 Liquid fill-drain line filter. The liquid fill-drain line shall be provided with a filter through which all liquid entering or leaving the inner shell through the fill-drain line must flow. The filter shall be located between the liquid fill-drain line shut-off valve and the disconnect fitting. The filter location shall be such as to insure ready access for inspection, cleaning, or removal.

3.9.1.7.1.1.1.4.1 Liquid fill-drain line filter performance. The liquid fill-drain line filter shall remove 98 percent by weight of all particles whose smallest dimension is 10 microns or greater (10 micron nominal rating). The filter shall further remove all particles whose smallest dimension is 40 microns or greater (40 micron absolute rating). In addition, the filter element shall be sized to pass liquid oxygen at a flow rate of 25 gpm without the pressure drop exceeding 2 psig when the filter has previously ingested not less than 5 grams of particles having the following size distribution:

<u>Particle size (microns)</u>	<u>Percentage by weight</u>
10 to 20	36 \pm 3
20 to 40	24 \pm 3
40 to 60	16 \pm 3
Over 60	24 \pm 3

The filter shall not permit bypass of the element under any combination of conditions, and shall be capable of withstanding a pressure drop of 50 psig across the element without damage.

3.9. 1.7.1.1.1.4.2 Liquid fill-drain line filter design. The filter shall be of in-line configuration with the element constructed from stainless steel or monel. Sintered or powdered metal material shall not be utilized unless backed up by a wire-wound or wire-mesh cloth element in which the wires have been fused under controlled conditions so as to positively prevent migration of particles that may be shed by the sintered or powdered metal portion. The filter element shall be fused to the housing in a manner which will prevent bypass of the element. Elastomeric seals shall not be used in the filter design or construction. The proper direction of flow shall be plainly marked on each side of the filter housing in a prominent location.

3.9.1.7.1.2 Vapor vent line. The vapor vent line shall be not less than one inch inside diameter, and shall be sized and installed to provide for:

- a. Cooling down of the liquid storage tank assembly to permit filling as described below within 15 minutes, without the inner shell pressure exceeding 15 psig, after all components (including the inner shell) have stabilized at 125°F.
- b. Filling the tank with liquid oxygen at any rate up to and including 10 gpm without the inner shell vapor pressure exceeding 15 psig when the tank is cold.
- c. Venting liquid through the line when the inner shell is being filled and the tank contains between 50 and 52 gallons of liquid.

3.9.1.7.1.2.1 Vapor vent line installation. The vapor vent line shall be installed to minimize heat transfer between the inner and outer shells. This line shall provide access to the inner shell for spray cleaning.

3.9.1.7.1.2.2 Vapor vent line shut-off valve. A manually operated shut-off valve, having a free passage size approximately equal to that of the vapor vent line inner diameter when fully opens shall be provided in the vapor vent line as near as practicable to the point where it enters the outer shell. The valve shall provide positive shut-off when closed. General design construction and mounting shall be as specified in 3.9.1.10.1 through 3.9.1.10.1.3.

3.9.1.7.1.2.2.1 Vapor vent line shut-off valve mounting. The vapor vent line shut-off valve shall be solidly mounted in a location readily accessible to an operator. The vapor vent line shut-off valve shall be so mounted to supporting members that force applied in opening or closing the valve will not damage the vapor vent line piping.

3.9.1.7.1.2.3 Vapor vent line discharge. The vapor vent line shall discharge toward the ground beneath the control housing assembly in a location where high concentrations of gas and liquid overflow will not

constitute a hazard or impinge or spray on other tank components. The line shall terminate in a 1 inch, female pipe thread, in an area which is convenient, for attachment of a hose from a purging unit or an overboard vent line during air transport.

3.9.1.8 Pressure build-up system. The pressure build-up system shall function to pressurize the transfer tank assembly inner shell vapor space to 90 psig within 2 minutes after closing the vapor vent and fill line shut-off valves when the transfer tank contains 10 liters or more of liquid oxygen.

3.9.1.8.1 Pressure build-up system components. The pressure build-up system shall consist of a vaporization coil and manual control valve, together with the connections, piping, mountings, instruments and accessories needed for proper and safe operation.

3.9.1.8.2 Method of operation. The pressure build-up system shall operate by vaporizing a portion of the liquid contained in the transfer tank and pressurizing the transfer tank inner shell vapor space with the resultant vapors. Vaporization of the liquid in the transfer tank shall be accomplished by passing the cryogenic liquid through an ambient air heated pressure build-up coil. The coil forms a direct external connection between the transfer tank inner shell liquid and the pressure control system.

3.9.1.8.3 Vaporization coil. The vaporization coil shall be designed and constructed to receive liquid from the transfer tank and vaporize it at the rate necessary for maintaining the 90 psig vapor space pressure by heat exchange with ambient air and discharge the resultant vapors into the transfer inner shell vapor space. The vaporization coil shall include all shrouding, baffling and ducting necessary for insuring proper airflow distribution over the heat exchange surfaces.

3.9.1.8.3.1 Vaporization coil materials. The vaporization coil and its associate piping, supports, attachments and connections shall be constructed from materials not attacked or adversely affected by contact with liquid oxygen or nitrogen, gaseous oxygen or nitrogen, water, dust, mud, moist air, or cleaning solvents.

3.9.1.8.3.2 Vaporization coil installation. The vaporization coil shall be installed where it will be protected from adverse environmental conditions and mechanical damage. The vaporization coil shall be connected in such a manner that it will function independently of the liquid fill line and liquid servicing line without interference or interdependence. The connection of the vaporization coil to the vent line shall be located in a readily accessible area and designed to permit easy disconnection of the vaporization coil from the vent line. A cap shall be provided to seal the hole in the vent line resulting from disconnection of the vaporization coil.

3.9.1.8.4 Operating controls. operation of the pressure build-up system shall require no control operation other than closing of the transfer tank vapor vent line valve and opening of the pressure build-up manual control valve.

3.9.1.8.4.1 Manually actuated controls. All manually actuated controls used in normal operation of the pressure build-up system shall either be mounted on the control panel or easily accessible.

3.9.1.9 Safety devices. Where necessary, pressure relief devices shall be provided for protection of the liquid storage tank assembly and its associated components. All pressure relief devices and drains shall be installed in readily accessible locations and, except for outer shell safety device, shall discharge all vented liquid or vapor toward the ground in a location which will insure against damage to equipment or danger to personnel and against creating fog where it will obscure controls, instruments, or fittings in the control housing assembly. All safety devices shall be fabricated from corrosion-resistant materials not adversely affected by extended contact with oxygen, moist air, water, or cleaning solvents.

3.9.1.9.1 Storage tank inner shell safety head. A bursting-disc type safety head utilizing a readily replaceable disc in a union-type fixture shall be provided to relieve the inner shell vapor phase pressure to the atmosphere should this pressure become excessive and the pressure relief valve fails to open. The safety head relief pressure shall be not less than 1-1/2 times the inner shell maximum working pressure (see 3.8.21).

3.9.1.9.1.1 Storage tank inner shell safety head installation. The inner shell safety head shall be installed with a sufficient length of tubing between itself and the vapor vent line to prevent frosting of the safety head unless the safety head actually ruptures to relieve the inner shell pressure. The discharge shall be into the vapor vent line between the vapor vent line shut-off valve and the vent line discharge.

3.9.1.9.2 Outer shell safety head. The outer shell safety head shall be as specified in 3.9.1.4.3.1.

3.9.1.9.2.1 Outer shell safety head installation. The outer shell safety head shall be installed in a location readily accessible for service and in a location which provides adequate protection from damage.

3.9.1.9.3 Transfer tank inner shell safety head. A bursting-disc type safety head utilizing a readily replaceable disc in a union-type fixture shall be provided to relieve the transfer tank inner shell vapor phase pressure to the atmosphere should this pressure become excessive and the pressure relief valve fails to open. The safety head relief pressure shall be not less than 1-1/2 times the transfer tank inner shell maximum working pressure (see 3.8.21).

3.9.1.9.3.1 Transfer tank inner shell safety head installation. The inner shell safety head shall be installed with a sufficient length of tubing between itself and the vapor vent line to prevent frosting of the safety head unless the safety head actually ruptures to relieve the inner shell pressure. The discharge shall be into the vapor vent line between the vapor vent line shut-off valve and the vent line discharge.

3.9.1.9.4 Inner shell vapor space pressure relief valve. The relief valve shall be designed to open at not less than 50 psig for the storage tank and 90 psig for the transfer tank. The relief valves shall be sized to insure against the inner shell vapor space pressure exceeding 60 psig for the storage tank and 110 psig for the transfer tank when:

- a. The tank is filled to not less than 90 percent of design capacity.
- b. The tank is placed in an ambient temperature of not less than 125°F.
- c. The build-up valve is left wide open,
- d. All other valves are closed.

3.9.1.9.4.1 Inner shell vapor space pressure relief device installation. The inner shell vapor space pressure relief device shall be designed and installed in a manner that will prevent freezing of the relief device when venting oxygen vapor. The relief device shall discharge all vented material into the vapor vent line between the vent line shut-off valve and vent line discharge.

3.9.1.9.5 Liquid fill-drain line pressure relief and drain valves.

3.9.1.9.5.1 Pressure relief valve. An automatic pressure relief valve shall be provided in the fill-drain line between the shut-off valve and the disconnect coupling for venting excess pressure from the fill-drain line. The relief valve shall be designed to open at a pressure in excess of that at which the inner shell vapor space pressure relief valve opens, but less than the safe working pressure of the fill-drain line.

3.9.1.9.5.1.1 Fill-drain line automatic pressure relief valve installation. The fill-drain line automatic pressure relief valve shall be installed with a sufficient length of tubing between itself and the fill-drain line to prevent frosting of the relief valve unless the relief valve actually opens to relieve the fill-drain line pressure.

3.9.1.9.5.2 Fill-drain line drain valve. A manually operated valve for draining liquid from the fill-drain line disconnect coupling when removing the fill hose shall be provided in the fill-drain line between the shut-off valve and the disconnect coupling, as near the disconnect coupling as practicable. The drain valve shall be located and installed so as to be readily accessible to an operator standing on the ground outside the tank

control housing assembly. If practicable, the automatic pressure relief valve and the drain valve may be combined into one unit. The drain valve shall discharge beneath the control housing assembly.

3.9.1.9.6 Additional pressure relief valves. Additional automatic pressure relief valves shall be installed in each circuit or component not specified and which can be so isolated by closing valves or otherwise that a dangerous pressure could build-up. These relief valves shall be designed to open at a pressure sufficiently low to insure against damage to the component or circuit affected. However, the operating pressure shall be in excess of that at which the inner shell vapor space pressure relief valve opens.

3.9.1.10 Controls.

3.9.1.10.1 Shut-off and control valves. Shut-off and control valves shall be provided wherever needed for control of the inner shell vapor phase pressure, vapor phase venting, liquid transfer and tank instrumentation.

3.9.1.10.1.1 Valve design and construction. Valves shall be designed and constructed to provide positive shut-off when closed and minimum resistance to flow when open. All valves handling low temperature liquid and gas shall be so designed that the packing gland is located not less than the distance specified in table I from the valve connection centerline. The stem and the stem housing on these valves shall either be fabricated from 18-8 stainless steel or other equally low heat conductive material, or the stem and stem housing shall be provided with 18-8 stainless steel or other equally low heat conductive material inserts equal in length to not less than one-half the distance specified in table I. Liquid level gage control and other instrument control and isolation valves may be of conventional construction.

3.9.1.10.1.1.1 Globe valves handles. Globe valves shall be provided with circular valve handles with a notched grip and a diameter equal to 3 inch per inch of valve nominal size, but not less than 1 inch.

3.9.1.10.1.1.2 Toggle valves. Toggle valves shall be provided with a valve handle which shall not exceed 6 inches long as measured from the stem axis.

3.9.1.10.1.1.3 Globe valve overtorque. The valves shall be designed and constructed to withstand a closing torque of 300 ± 10 lb in. per inch of nominal size, with the valve bodies at either ambient temperature or the atmospheric pressure boiling temperature of liquid oxygen or nitrogen. Such operations shall not result in a parts failure or a leakage rate in excess of that specified herein when subsequently closed with a torque of 60 ± 5 lb in. per inch of valve nominal size.

3.9.1.10.1.2 Toggle valve and globe valve material. The valves shall be fabricated from corrosion resistant material not adversely affected by extended contact with oxygen, nitrogen, argon, hydrogen, helium, moist air, water, or cleaning solvents such as trichlorotrifluoroethane.

3.9.1.10.1.3 Valve mounting. All valves used during liquid transfer shall be so mounted and installed that they can be readily opened or closed, and so that their control handles will be readily accessible to an operator standing at the control area. All valves shall be so mounted to supporting members or large size piping that force applied to the control handles in opening or closing the valves will not damage the tank piping, and so mounted that the operator will be protected from liquid spray if a fitting or coupling leaks or breaks.

3.9.1.11 Tank instrumentation. All instruments necessary for effective and safe operation of the tank shall be provided. These shall include the following:

3.9.1.11.1 Liquid level gage. A liquid level gage, designed to directly indicate the level of the liquid oxygen in the liquid storage tank assembly inner shell, with an accuracy of ± 3 percent of tank design capacity, shall be provided.

3.9.1.11.1.1 Gage type. The gage dial shall be magnetically and mechanically coupled to a float sensor inside the storage tank. Dial face of the gage shall be a minimum of 4 inches.

3.9.1.11.1.2 Graduations. The liquid level gage shall be graduated in percentage of full of the storage tank. Gage will read from 0 to 100 percent, graduated in increments of 10's.

3.9.1.11.1.3 Liquid level gage mounting. The liquid level gage shall be securely mounted at the controls end of the unit and where it will be readily visible during filling of converters, to an operator standing on the ground, at the control end of the unit.

3.9.1.11.2 Vapor phase pressure gage. A pressure gage with a dial diameter of not less than 2-1/2 inches shall be provided for indicating the inner shell vapor pressure. The gage shall be graduated over approximately 270 degrees of the dial face and shall be accurate to within ± 2 percent of full-scale range.

3.9.1.11.2.1 Range. The indicating range of the vapor phase pressure gage shall be approximately 1-1/2 times the normal working pressure of the tank inner shell, unless a higher range is necessary to prevent the indicator from moving off scale before reaching the relief pressure of the inner shell safety head and the vapor space pressure relief valve.

3.9.1.11.2.2 Vapor phase pressure gage installation. The vapor phase pressure gage shall be securely mounted in the control area position where it will be readily visible during liquid transfer or filling to an operator standing at the control panel. The gage shall be so installed that no combination of valve or control settings can interfere with it indicating the inner shell vapor space pressure.

3.9.2 Control housing assembly. A sturdy, heavy-gage, sheet metal housing assembly shall be fabricated on the opposite end of the tank from the lunette eye. The housing shall contain and provide protection for the tank controls, instrumentation and accessories.

3.9.2.1 Control housing assembly design and construction- The control housing assembly shall be designed and constructed to protect the enclosed components from mechanical damage, direct solar radiation, rain, sleet, snow, mud, sand and other adverse weather and environmental conditions. The control housing assembly shall be so constructed that it, or Applicable sections thereof, can be readily removed from the liquid storage tank assembly for maintenance or removal of components.

3.9.2.1.1 Control housing materials. The control housing assembly shall be constructed from material resistant to corrosion caused by wetting with condensed water, and so that retention of condensed water within the control housing will be effectively prevented.

3.9.2.1.2 Top. If practicable, the top of the control housing assembly and the tops of all protuberances therefrom shall be shaped and slanted to resist the retention of snow, rain, or sleet. Doors and panels that must be opened for use of the tank shall be so constructed and installed that snow or ice will not lodge thereon in a manner that will prevent easy operation or access.

3.9.2.2 Size. The control housing assembly shall be of sufficient size to provide ready access to the enclosed components for operation, servicing, maintenance and repairs, and to provide space for the storage of accessories and tools.

3.9.2.3 Access openings. Doors or hinged panels shall be provided in the control housing assembly as necessary for access for operation, inspection, servicing maintenance and repair of the equipment. The doors and hinged panels, whose positions may have to be regulated, shall be provided with means for securing them in any position from fully closed to wide open when subjected to wind gusts up to and including 70 mph.

3.9.2.3.1 Hinges and locking devices. All doors and hinged panels shall be equipped with sturdy hinges and locking devices that will hold them securely closed during storage. Locking devices shall be provided for securely holding open the doors and panels that must be opened for tank use. The locking device shall securely retain the doors or panels in the set position even when subjected to wind gusts up to and including 70 mph.

3.9.2.3.2 Locking devices. The locking devices on all doors and hinged panels that must be opened for normal operation of the tank shall be readily operable by personnel wearing heavy arctic mittens. *

3.9.2.4 Ventilation provisions. Ventilation openings or other air circulation provisions shall be provided in the control housing assembly as necessary to prevent accumulation of gases or the accumulation of fog resulting from moist air being chilled in the control housing during liquid transfer or tank filling. The ventilation openings shall be so located or shielded that the entrance of rain, snow, or other precipitation will be effectively prevented.

3.9.3 Chassis. The tank shall include an integral two-wheel trailer chassis with a retractable third wheel, designed and constructed to support the tank and other components specified herein. The chassis shall conform to the requirements of MIL-M-8090 for type II, group A equipment. The chassis shall include a stop to prevent damage to the liquid storage tank assembly or other components of the unit when the tow bar is raised sufficiently to cause the back of the unit to contact the ground. The lunette eye, which is attached to the towbar, shall be adjustable to hook up a tow tractor at 12 and 24 inches above the ground.

3.9.3.1 Wheels, tires, tubes and hubs. The two main wheels shall be equipped with size 6.00 by 9, 6 ply tires and tubes in accordance with MIL-W-8005. The retractable wheel shall be size 3.50 by 6, 4 ply.

3.9.3.2 Weight distribution. The weight shall be so distributed that when the fully loaded unit is parked on a level surface with the lunette eye 15 inches above the ground, not more than 140 lbs or less than 65 lbs force applied at the lunette eye will be required to raise the landing gear clear of the supporting surface. In addition the weight shall be so distributed that when a full converter is sitting on the servicing tray and 5 gallons or less is in the main tank and the transfer tank is full, 20 lbs or more will be applied to the front wheel.

3.9.3.3 Parking brakes. The unit shall be provided with two-wheel, expanding-shoe, automotive-type parking brakes. The control lever shall be located at the front of the unit near the lunette eye.

3.9.3.4 Suspension. The tank shall be solidly mounted to the running gear. The tire pressure shall be selected to be low enough to provide the necessary good riding qualities to prevent damage to the tank or its accessories without requiring springs. The tire pressure shall not exceed 15 psig.

3.9.3.5 Safety chains. Safety chains shall be provided.

3.9.3.6 Reflectors. Reflectors shall be provided.

3.9.3.7 Service brakes. Service brakes need not be provided.

3.9.3.8 Bumper. A rear bumper need not be provided.

3.9.3.9 Fenders. Fenders need not be provided.

3.9.3.10 Lighting devices and wiring. Lighting devices and wiring need not be provided.

3.9.3.11 Mud flaps. Mud flaps need not be provided.

3.9.3.12 Pintle hook. A pintle hook need not be provided.

3.9.3.13 Towing in train. The unit need not be designed for towing in train.

3.9.4 Converter trays. A full width stainless steel tray will be provided which will serve to support the converter. The tray shall be of adequate size and shape to provide support and restraint of the converter while servicing on a ship which is listing or rolling. The tray shall be provided with 2 rails mounted on it so that a converter could be positioned in place on top of the tray.

3.9.5 Converter full indicator. A vapor pressure thermometer type device shall be provided to indicate the converter is full.

3.9.6 Bumpers.

3.9.6.1 Size. Bumpers shall be provided in the form of a 2 inch tube, with a wall thickness of not less than 0.083 inch, around the side periphery of the entire trailer. Another bumper shall be provided in the form of a 2 inch tube, with a wall thickness of not less than 0.083 inch, running up and over the top of the container, which may be used for the purpose of hand towing the unit from either side, while maintaining adjacent access to the brake handle.

3.9.6.2 Vacuum jacketed plumbing. Any vacuum jacketed plumbing or equipment, which is susceptible to damage, shall be protected by bumpers or skids.

3.9.7 Converter filler line installation. The converter filler line shall be mounted on a flexible line to accommodate mating with the fill valves on the converters. The flexible line shall be designed to minimize heat induction and be adequate in length to provide ease of connection to the converter fill valve when converter is properly positioned on converter tray.

3. 9.% Vent return line.

3.9.8.1 Routing of vented vapors and liquid. Vapors and liquid vented from the converters shall be routed back into the tank through a flexible line connected to the converter vent. The flexible line shall be designed to minimize heat induction and be adequate in length to provide ease of connection of the vent connector on the converter.

3.9.8.2 Vent connector. The vent connector shall not leak in excess of 3 cubic inches per hour when pressurized to 100 psig. The connector must be of an adjustable locking configuration to provide adequate seal when servicing a converter with worn seals. The connector shall not freeze to the converter during servicing operations.

3.10 Dimensions. The overall dimensions of the unit, with all access openings closed, shall not exceed the following:

<u>Location</u>	<u>Inches</u>
Length	90
Width	55
Height	36

3.11 Weight. The weight of the empty tank, its accessories and including the trailer chassis, shall not exceed 700 lbs.

3.12 Finishes and protective coatings.

3.12.1 Exposed parts and surfaces. All exposed metal parts and surfaces, except parts and surfaces that contact high purity cryogenic fluids, shall be sand blasted to near white.

3. 12.1.1 Painting of exposed parts and surfaces. Apply to prepared surfaces, to be painted, one coat of epoxy primer per MIL-P-23377, class 2. Finish with 2 coats of polyurethane coating per MIL-C-81773, yellow, color number 13538 of FED-STD-595. Two six inch bands of green, color number 14187, separated by a six inch white band, color number 17875, of FED-STD-595 shall be painted with enamel, or marked by decal around the top half of the middle of the tank.

3.13 Operational markings.

3.13.1 Contents marking. The lettering, LIQUID OXYGEN FOR BREATHING PURPOSES ONLY, KEEP FREE FROM OIL AND GREASE, FRAGILE, DO NOT DROP and NO SMOKING WITHIN 50 FEET, shall be horizontally centered, beginning 3 inches from the top center of the tank, measured along the circumference of the shell, on the right side of the tank. The words LIQUID OXYGEN, shall be 1-3/4 inches, silver, reflective letters and all other letters shall be 1 inch,

silver, reflective letters on a solid red reflective background. The letters, LIQUID OXYGEN, in 1-3/4 inch, silver, reflective letters on a 2-3/4 inch wide reflective background, shall be horizontally centered, beginning 3 inches from the top center of the tank, measured along the circumference of the tank, on left side of the tank.

3.13.2 Warning plates. A weatherproof warning plate, containing the following information, shall be provided and securely mounted on unit adjacent to vent line fitting.

WARNING

ALL VALVES MUST BE CLOSED AND
AN OVERBOARD VENT LINE ATTACHED
TO THE VENT LOCATED NEAR THIS
TAG DURING AIR TRANSPORT.

3.13.3 Tire inflation red warning plate. A weatherproof, red warning plate, cautioning against over inflation of the tires and containing instructions concerning the pressure to which they must be inflated for proper operation of the equipment, shall be attached to the unit near each main wheel.

3.13.4 Operating and precautionary instructions. Brief operating and precautionary instructions shall be permanently affixed on or near the tank control area. The instructions shall be clear, concise and adequate to enable operation of the tank without damage to the equipment or injury to personnel. Instruction panels shall be made from anodized sheet aluminum or sheet zinc, not less than 0.050 inch thick, and etched to produce raised markings with a black or other dark color background and with a border of not less than 1/4 inch.

3.13.5 Transportation data plate. A transportation data plate shall be provided as specified in MIL-M-8090, except that the marking of the plate may be as specified in 3.13.4 (see 6.2).

3.13.6 Lifting instruction plate. An instruction plate containing all information necessary for transportation personnel, to rig a safe lifting sling from common cable and spreader bar components and to safely lift the tank with a 3 g acceleration, shall be securely attached to the outside of the control housing assembly near the transportation data plate. The lifting instruction plate shall be of the same material and prepared in the same manner as the transportation data plate.

3.13.7 Color marking. The indicating scale of each instrument (pressure gage, differential pressure indicator, temperature indicator, liquid level indicator, et cetera) used for normal operation and control of the tank shall be permanently and plainly marked with green and red to show the proper operating and other-than-proper-operating or danger zones respectively.

3.14 Identification of product. Equipment, assemblies and parts shall be marked for identification in accordance with MIL-STD-130.

3.14.1 Tank nameplate location. The tank nameplate shall be securely attached to the outside of the control housing assembly in a readily visible location.

3.15 General cleaning instruction. Following completion of fabrication and assembly operations, the tank shall be thoroughly cleaned and degreased to remove dirt; excess soldering, brazing, and welding flux; welding slag; scale; loose, spattered, or excess solder; metal chips; loose or chipped paint; spilled chemicals; or other foreign materials. Cleaning shall be continued until visual inspection shows no evidence of contamination or foreign matter.

3.15.1 Decreasing. Prior to assembling, tank surfaces, parts, fittings, et cetera, that will be in contact with high-purity oxygen shall be degreased by flushing with a cleaning compound, MIL-C-81302 or using a vapor phase degreaser in accordance with O-T-236 or O-T-634. Components shall be cleaned by immersing, scrubbing or pressure spray with MIL-C-81302 cleaning compound or ultrasonics may be used in conjunction with vapor decreasing or MIL-C-81302 cleaning compound. After completion of the cleaning and when assembled, a General Electric Type H Leak Detector or equivalent Halide testing apparatus shall be used to determine the absence of the cleaning compound. Precautions shall be taken to insure that solvents do not contact parts fabricated from incompatible materials,

3.15.2 Purging. The liquid storage tank assembly inner shell, prior to packaging, shall be purged with hot, dry oxygen conforming to MIL-O-27210, type I or nitrogen conforming to BB-N-411, type I, class 1, grade B by connecting purge unit to the fill-drain line and opening vent valve so that gas will flow through interconnecting piping and storage tank. The exit gas should be at least 100 F before concluding purge.

3.15.2.1 Pressurization following purging. Following the purging and cool down, the inner shell shall be pressurized to not less than 10 psig nor more than 20 psig with clean, dry, oil-free nitrogen gas, after which every valve and line leading into the inner shell shall be closed. The ends of all pipes, tubes, and couplings shall be securely sealed with pressurize-sensitive tape conforming to PPP-T-60. The liquid storage tank assembly annular insulation space shall be evacuated to the absolute pressure recommended in the tank operating and servicing instruction handbook, if it is not at or below that pressure. The vacuum line shut-off valve shall be tightly closed after the evacuation and the vacuum line sealed with the provided cap.

3.15.3 Tag (stating tank is clean and pressurized). A type A tag conforming to UU-T-81, with tague and painting waterproof, stating that the liquid

storage tank assembly inner shell is clean and pressurized with nitrogen gas conforming to BB-N-411, type I, class 1, grade B and indicating the date and the pressure to which the annular insulation space has been evacuated, shall be securely attached to the vapor vent line shut-off valve handle in a conspicuous location.

3.16 Lubrication. All tank machined bearing surfaces, that are normally lubricated in operation and that do not come into contact with the contained product, shall be thoroughly lubricated with the recommended military or federal specification lubricants so as to be ready for immediate operation.

3.17 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable.

3.18 Workmanship. All parts of the tank shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to the following:

- a. Freedom from blemishes, defects, burrs and sharp edges.
- b. Accuracy of dimensions, radii of fillets and marking of parts and assemblies.
- c. Thoroughness of soldering, welding, brazing, painting and riveting,
- d. Thorough removal of rust, slag, scale, flux and other foreign materials from inside of the tank and from all piping, valve connections, filter housing and from other surfaces that contact the oxygen product.
- e. Alignment of parts and tightness of assembly screws, bolts, rivets, et cetera.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 First article Inspection. First article inspection shall consist of all the examinations and tests of this specification.

4.3.1 First article test plan. Unless otherwise directed, the manufacturer shall submit a test plan for review and approval to the Commanding Officer, Naval Air Engineering Center, Lakehurst, NJ 08733, Code 92714 prior to first article sample testing (see 6.2). The test plan shall show the instrumentation, layouts, electrical hookups, environmental test equipment, test sequences and facilities to be used for first article sample testing. The test plan shall also include the following calculations:

4.3.1.1 Evaporation loss calculation. A detailed calculation of the heat leakage into the inner tank to determine a theoretical evaporation loss rate. Consider all modes of heat transfer into the inner tank including convection, conduction and radiation heat transfer.

4.3.1.2 Vapor phase pressure calculation. Show by calculation that the vapor phase pressure in the storage tank will stabilize at 50 psig and will attain 90 psig in the transfer tank within 2 minutes through a detailed thermodynamic analysis of the entire pressure buildup system. Include the sizing calculation of the pressure build-up coil and associated piping and include cooldown effects of the pressure build-up coil and heat transfer during two phase flow.

4.3.2 First article samples. Unless otherwise specified, as soon as practicable, after the award of the contract or order, one complete tank, 3 bursting discs, one of each type of valve, one filter and one of each size, style and construction of dissimilar metal vacuum joints shall be subjected to the first article inspection. The samples shall be representative of the construction, workmanship, components, and materials to be used during production. When a manufacturer is in continuous production of these units from contract to contract, further first article tests on the new contract may be waived at the discretion of the procuring activity (see 6.2). Approval of the first article samples or the waiving of the first article inspection does not preclude the requirements of submitting to the quality conformance inspection. The first article inspection facility shall be as directed by the contracting officer (see 6.2).

4.3.2.1 Test report. Upon completion of the first article inspection, three copies of a test report, prepared in accordance with MIL-STD-831, shall be supplied to the Commanding Officer, Naval Air Engineering Center, Lakehurst, NJ 08733, Code 92714.

4.3.2.1.1 Reliability and maintainability information. The following information shall be submitted as an appendix to the first article test report:

- a. A description of and the appropriate information below concerning any first article tests that were conducted prior to those described in the first article test report and that were intended to apply to the contract:

- (1) All failures, servicing, adjustments, maintenance and irregular functioning shall be accumulated operating time, cycles, miles, or position in the test procedure, as appropriate" Test conditions at the time of the events identified. shall be recorded.
- (2) Test operator and maintenance technician errors, test equipment and test facility failures, and other events that might act as grounds for a request, that an equipment failure not be counted as a reliability failure, shall be recorded. Detailed descriptions of the events and the analysis to substantiate any such requests made shall be included and shall be clearly cross-referenced to each applicable failure.
- (3) A summary of the engineering analysis and of any tests conducted to determine assignable causes for any or irregular functioning.
- (4) A summary of the engineering analysis leading to any corrections made to design, construction? quality control, or other procedures, or leading to any corrections to be made to production items or proposed to be made. The summary shall also include an analysis of the predicted effectiveness of such corrections. Failures that have been corrected by design changes or by other means shall be counted as reliability failures until the corrections have been both analyzed and verified by test sufficiently to substantiate the effectiveness of the correction to the satisfaction of the procuring activity.
- (5) Clock time and manhours required for each maintenance and servicing action taken during the tests. A brief description of the experience and qualifications of the personnel taking such actions shall be included. The information shall include a summary of the data resulting from the servicing and maintenance tests. In addition, the clock time and the manhours required for actual access and disassembly time shall be recorded for any tear-down inspections done for mechanical checks. The number of parts and assemblies removed and causing interference shall be noted for each tear-down and inspection made. Administrative time, such as filling out records, and logistics time, such as obtaining parts from stock, need not be included.
- (6) Test activity or contractor comments on item features or requirements that, if modified, should improve the item.

(7) Test activity of contractor comments on use or maintenance conditions to be avoided or cultivated to increase the reliability or useful life of the item.

- b. Any of the above information that is already included in the first article test report body or in other documents submitted to the procuring activity need not be repeated in the information required by this paragraph, but clear reference to the location and to the date of submission of the data shall be included.
- c. All table and column headings and all abbreviations and symbols used shall be clearly defined where used or in a table of abbreviations and symbol definitions placed in the front part of the appendix.

4.4 Quality conformance inspection. The sampling and inspection levels shall conform to MIL-STD-105.

4.4.1 Sampling.

4.4.1.1 Inspection lot.

4.4.1.1.1 Tank. An inspection lot size shall be expressed in units of one tank made under essentially the same conditions and from the same materials and components. The sample unit shall be one tank.

4.4.1.2 Sampling for tests and examinations of tanks. The sample size, acceptance criteria, tests and examinations required for the tanks shall be as specified in table II and 4.6.

4.5 Test conditions.

4.5.1 Tools. Special tools and field equipment shall be used to the maximum practicable extent during testing. Use of these tools shall be sufficient to determine their usefulness. Instances where the special tools furnished are inadequate shall be recorded in detail.

4.5.2 Instrumentation.

4.5.2.1 Pressures. Pressure differentials, except pressure drops in the fill and servicing lines, shall be measured by means of the pressure gages and differential pressure meters furnished as part of the tank.

4.5.2.1.1 Absolute pressures below 1 mm Hg shall be measured by the use of calibrated instruments designed to read total pressures (including permanent gases and condensable vapors).

4.5.2.1.2 Pressures in excess of atmospheric shall be recorded in pounds per square inch gage (psig). Pressures up to and including atmospheric shall be reported in microns or millimeters (mm) of mercury (Hg) absolute, as applicable. Differential pressures shall be reported in inches of water or inches of mercury, as applicable.

4.5.2.1.3 Barometric pressure. Barometric pressure shall be measured by a properly calibrated mercurial barometer and reported in millimeters of mercury absolute.

4.5.2.2 Temperatures. Temperatures shall be measured by appropriately located thermometers or thermocouples used with calibrated potentiometers. Temperatures shall be reported in degrees Fahrenheit (°F).

4.5.3 Flow rates.

4.5.3.1 Liquid. Liquid oxygen flow rates shall be determined by either of the following methods:

- a. Passing the liquid through a properly calibrated recording or totaling-type liquid flowmeter designed to handle the liquid being measured.
- b. Collecting the liquid and weighing it on an accurate scale.

4.5.3.1.1 Recording of liquid flow rates. Liquid flow rates shall be recorded in gallons per minute (gpm) of the liquid at its atmospheric pressure boiling temperature.

4.5.3.2 Gas. Gaseous oxygen flow rates shall be determined by passing the material through a properly calibrated recording or totaling-type gas meter designed to handle the gas being measured.

4.5.3.2.1 Expressing of gaseous flow rates. Gaseous flow rates shall be converted to weight flow rates for the material handled and expressed in pounds per hour, pounds per minute, et cetera, as applicable.

4.5.4 Vacuum pumping. A vacuum pump shall be connected to the tank vacuum pump-out operator and the annular space evacuated as necessary.

4.5.4.1 Vacuum seal. Upon completion of the vacuum pumping, the vacuum pump shall be disconnected.

4.5.5 Test data.

4.5.5.1 Correction of data. If the tests specified herein cannot be conducted under the specified conditions, the tests may, upon approval of the Naval Air Engineering Center, Lakehurst, NJ 08733, Code 91714, be

conducted under other conditions and the performance under the specified conditions calculated from the test results obtained. The manner of calculation shall be demonstrated, and actual test data, proving the correctness of the calculation methods, shall be presented for review by the procuring activity.

4.5.5.2 Psychometric data. Wet- and dry-bulb temperature readings shall be recorded at the intervals specified under the individual tests.

4.5.5.3 Barometric pressure. The barometric pressure shall be measured and recorded at the intervals specified under the various test procedures specified under 4.6.

4.5.5.4 Tolerances.

4.5.5.4.1 0 to 10 microns Hg. Data on absolute pressures measured in the range from 0 to 10 microns Hg shall be accurate to within 0.5 microns Hg.

4.5.5.4.2 10 to 50 microns Hg. Data on absolute pressures measured in the range from 10 to 50 microns Hg shall be accurate to within 2 microns Hg.

4.5.5.4.3 50 to 250 microns Hg. Data on absolute pressures measured in the range from 50 to 250 microns Hg shall be accurate to within 5 microns Hg.

4.5.5.4.4 250 to 500 microns Hg. Data on absolute pressures measured in the range from 250 to 500 microns Hg shall be accurate to within 10 microns Hg.

4.5.5.4.5 500 - 1000 microns Hg. Data on absolute pressures measured in the range from 500 to 1,000 microns Hg (1 mm Hg) shall be accurate to within 20 microns Hg.

4.5.5.4.6 From 1 mm Hg to atmospheric. Data on absolute pressures measured in the range from 1 mm Hg to and including atmospheric shall be accurate to within 0.1 mm Hg.

4.5.5.4.7 Atmospheric to 10 psig. Data on gage pressures measured in the range from atmospheric to 10 psig shall be accurate to within 1/2 psig.

4.5.5.4.8 10 to 50 psig. Data on gage pressures measured in the range from 10 to 50 psig shall be accurate to within 1 psig.

4.5.5.4.9 In excess of 50 psig. Data on gage pressures in excess of 50 psig shall be accurate to within ? percent of the actual numerical reading.

4.5.5.4.10 Weight flow rates. Data on weights, weight flow rates, and volume flow rates shall be accurate to within 1 percent of the numerical reading.

4.5.5.4.11 Gas and vapor flow rates. Data on gas and vapor flow rates shall be accurate to within 1 percent of the numerical reading.

4.5.5.4.12 Temperature. Data on temperature shall be accurate to within 2°F.

4.5.5.5 Pressure test record. A record of the pressures at which each tank component is tested and the length of time during which it is subjected to the pressure shall be recorded.

4.5.6 Preliminary run-in. The nature and extent of running-in shall be determined by the manufacturer and shall be performed prior to the testing specified herein. All necessary adjustments, other than normal control adjustments, shall be made during this run-in and shall remain undisturbed thereafter.

4.6 Inspection methods.

4.6.1 Visual examination.

4.6.1.1 Storage tank. Every storage tank shall be examined visually (for critical defects) to determine conformance to this specification. The classification of defects, table III, shall be used to classify the defects found.

4.6.1.1.1 Dimensions. Each storage tank, selected as a sample unit from the lot, shall be checked dimensionally to determine conformance to the dimensions specified herein.

4.6.1.2 Packaging. Each of the fully prepared shipping containers, containing a storage tank, selected as a sample unit from the lot, shall be examined to determine that the packaging, packing, and marking conform to this specification. The classification of defects, table IV, shall be used to enumerate the defects found.

4.6.2 Spririg-loaded relief valve test. Prior to installation on the storage tank, each spring-loaded relief valve shall be subjected to a gradually increasing pressure of clean, dry, oil-free air or nitrogen at its inlet until the relief valve opens. The pressure shall then be gradually reduced until the valve completely reseals. This procedure shall be repeated not less than twice. Following the relief valve operation, maintain the pressure that completely resealed the valve and then check the valve for leakage by the application of a leak detection compound on all exterior valve surfaces. The valve shall pass the requirements specified in 3.8.1.

4.6.3 Pressure test. The tank and each component and circuit of the tank that, operates under positive pressure in normal service shall be pressure tested in accordance with section VIII of the ASME Boiler and Pressure Vessel Code. Automatic pressure relief devices shall not be installed for this test. The tank and each component and circuit of the tank shall pass the requirements specified in 3.8.2.

4.6.4 Cleanliness test.

4.6.4.1 Particulate matter test. Fill the liquid storage tank and the transfer tank with liquid nitrogen to not less than 90 percent of design capacity. The tank shall then be permitted to set undisturbed for not less than 2 hours. Following the 2 hour period, the filter shall be removed from the fill-drain line and a 2 liter or larger Dewar flask placed under the discharge end of the fill-drain line coupling, the shut-off valve opened, and not less than 1 liter of the first liquid discharged through the line collected in the Dewar flask. Also 1/2 liter of liquid shall be collected from the transfer tank through the filler valve. The samples shall be combined and then evaporated to dryness. The residue shall pass the requirements specified in 3.8.3.1.

4.6.4.2 Total solids test. After the particulate matter test, clean and weigh the filter to an accuracy of 0.1 gram. Replace the filter in the fill-drain line and then discharge all the liquid in the storage tank through the fill-drain line filter at a rate of not less than 10 gpm. Remove the filter from the fill-drain line, dry the filter and then reweigh the filter. The tank shall pass the requirements specified in 3.8.3.2.

4.6.5 Liquid storage capacity test. The tank storage capacity shall be determined by filling the inner shell with a liquid, with the tank setting on its wheels on a flat, level surface, until the filling liquid overflows through the vapor vent line, recording the liquid level gage, and then either measuring the volume of the filling liquid or determining its volume from weights before and after filling. The inner shell shall then be filled completely to determine total internal volume, and quantity of filling liquid determined as above. The actual liquid volume when filled to overflow through the vapor vent line and when completely filled shall both be recorded in US gallons and shall be accurate to within 1/2 gallon. The tank storage capacity at which liquid starts to discharge through the vapor vent line and the total internal volume shall pass the requirements specified in 3.8.4.

4.6.6 Transportability and handling tests.

4.6.6.1 Air transport flight and taxiing acceleration forces. The completely assembled tank shall be filled to design capacity with a cryogenic liquid having a density of not more than 9.5 pounds per US gallon and pressurized to not less than 45 psig. Liquid nitrogen may be used as the filling liquid if the acceleration loads are increased to not less than 1.42 times the specified value. While so filled and pressurized, the tank shall be subjected to the flight and taxiing acceleration force loads specified in MIL-A-8421, except the lateral loads shall be 3 g. The tank shall pass the requirements specified in 3.8.5.

, 4.6.6.2 Vibration. The complete tank filled as specified in 4.6.6.1, shall be subjected to the vibration testing specified in MIL-STD-810, method 514.2 category G, procedure X, curve AW. During and after each phase of the testing the tank, the test instrumentation and the data being accumulated shall be observed for resonance of piping, instruments, accessories, braces, brackets and other installed parts, devices, and equipment; loosening or loss of threaded, riveted, or other fasteners; and other damage or indications of impending failure of the overall tank or any of its components. Full details of resonances, loosening of parts or fasteners, or other damage or indications of impending failure shall be recorded on the test data sheets. Programmed vibration testing not completed because of a failure or impending failure, including any remaining resonance dwell, shall be repeated after corrective action. The tank shall pass the requirements specified in 3.8.5.

4.6.6.2.1 Dissimilar metal vacuum joints. Dissimilar metal vacuum joints (see 6.3.6) used in the tank construction shall be tested as follows:

- a. Subject the joint assembly to 10 thermal shocks. Each thermal shock shall be accomplished by first heating the complete joint assembly to not less than 125°F and then, before the joint has cooled below 125°F, quickly submerging the complete joint assembly in liquid nitrogen at its atmospheric pressure boiling temperature. The joint assembly shall remain submerged in the liquid nitrogen until the joint has cooled to approximately liquid nitrogen temperature. The joint assembly will be considered to have reached liquid nitrogen temperature when bubbles cease to emanate from its surface in large numbers.
- b. Secure the joint assembly by one end only (with the other end free to move) to a vibration input device which will vibrate the joint assembly in liquid nitrogen. The joint assembly shall then be subjected to axial vibration at a frequency of 60 cps and a double amplitude of not less than 0.050 inch for not less than 30 minutes while the joint assembly is submerged in liquid nitrogen at its pressure boiling temperature.

- c. Secure the joint assembly as in b, above. The joint assembly shall then be subjected to lateral vibration at a frequency of 60 cps and a double amplitude of not less than 0.200 inch for not less than 30 minutes while the joint is submerged in liquid nitrogen at its atmospheric pressure boiling temperature. Using a helium mass spectrometer, operating at its maximum sensitivity, check for any leakage rate increases by comparing checks prior to and following the temperature shock and vibration testing specified above.

The dissimilar metal vacuum joint shall pass the requirements specified in 3.8.5 and 3.9.1.2.2.

4.6.6.3 Emergency landing acceleration forces. The completely assembled tank shall be filled to design capacity with a liquid having a density of not less than 9.5 lbs per US gallon and pressurized to not less than 45 psig. While so filled and pressurized, the tank shall be subjected dynamically to the emergency landing acceleration force loads specified in MIL-A-8421, except the shock pulse shall be approximately one-half sine wave of not less than 30 milliseconds (ins) or more than 40 ms duration. The tank shall pass the requirements specified in 3.8.5.

4.6.6.4 Hoisting and tie-down provision test. The completely assembled tank shall be filled to design capacity with a liquid having a density of not more than 9.5 lbs per US gallon. Weights totaling not less than 2,220 lbs shall be so attached to the tank that the combined weight of the filled tank and the weights will be supported by the hoisting and tie-down rings when the tank is raised by an overhead crane. The tank and weights combination shall then be raised to a height of not less than 3 feet above the floor by a single-hook overhead crane using the hoisting and tie-down rings, held in that position for not less than 1 minute and then lowered to the floor. This procedure shall be repeated three times. The tank shall pass the requirements specified in 3.8.5.

4.6.7 Vacuum retention tests.

4.6.7.1 First article vacuum retention. Following the air transport flight and taxiing acceleration force testing specified in 4.6.6.1 and the lifting provision tests, the liquid storage tank assembly inner shell shall be filled with liquid nitrogen to not less than 60 percent of design capacity. The liquid storage tank assembly shall then be permitted to temperature stabilize until a constant annular insulation space absolute pressure is obtained. After temperature stabilization is reached, and with the inner shell vapor space at approximately atmospheric pressure, the annular insulation space absolute pressure shall be determined. The inner shell vapor space shall then be pressurized to not less than 30 psig and the tank allowed to set for not less than 7 days (168 hours) so filled and pressurized. Vibration testing shall then be conducted on the tank following evacuation and sealing

of the annular insulation space either prior to or during the vacuum retention test. Following completion of the test, the inner shell vapor space pressure shall be reduced to atmospheric. The tank shall pass the requirements specified in 3.8.6.

4.6.8 Heat leak evaporation loss rate test.

4.6.8.1 First article test. The initial first article heat leak evaporation loss rate test shall consist of the following individual test operations conducted in the order listed. Throughout the complete test, the inner shell vapor phase pressure shall remain at as near atmospheric pressure as possible.

4.6.8.1.1 Following the vacuum retention test and with the tank remaining filled to not less than 50 percent of design capacity with liquid oxygen or nitrogen, the tank shall be placed in a location where the ambient temperature shall remain at not less than 125°F throughout the periods specified.

4.6.8.1.2 The inner shell vapor space shall be vented to atmospheric pressure for not less than 24 hours.

4.6.8.1.3 The tank shall remain under the specified ambient temperature and vapor phase pressure conditions for 72 hours while heat leak evaporation rate losses for the tank are determined by weight. During this 72 hour period, the upper surface of the tank shall be exposed to the full impact of solar or equivalent heat radiation of 100 to 120 watts per square foot for three separate periods of not less than 8 hours each, with each exposure followed by a period of not less than 16 hours during which no solar radiation is applied. The total weight of vapors vented during the test, the weight of vapors vented since the preceding reading, the average ambient temperature to which the tank has been subjected during the preceding period shall be recorded at intervals of not to exceed 8 hours during the 72 hour test. The actual loss rate for each reading, the average actual loss rate over the entire 72 hour test period and the average ambient temperature to which the tank was exposed during the 72 hour test period shall be calculated. The evaporation loss rates shall be reported as the pounds of liquid oxygen vaporized per 24 hour day, and shall meet the requirements specified in 3.8.7.1.

4.6.8.1.4 The tank shall be removed from the high temperature test conditions and exposed to ambient temperature conditions for not less than 36 hours to permit temperature stabilization. The tank shall then be subjected to the individual acceptance evaporation loss rate test.

4.6.8.2 Quality conformance test. Following the vacuum retention test and with the inner shell remaining filled to not less than 50 percent of design capacity, the tank shall be placed where it will be subjected to

local or shop ambient temperature throughout the test. The inner shell vapor space shall be vented to atmospheric pressure for not more than 24 hours. The heat leak evaporation loss rate for the main tank shall then be determined by weight. Throughout the test, the inner shell vapor phase pressure shall remain at as near atmospheric pressure as possible.

4.6.8.2.1 The average ambient temperature to which the tank has been subjected during the preceding period, and the average barometric pressure to which the tank has been subjected during the preceding period shall be recorded at intervals of not to exceed 8 hours throughout the 72 hour test. The actual loss rate in pounds for each reading, the average actual loss rate in pounds over the entire 72 hour test period and the average ambient temperature to which the tank was exposed during the 72 hour test period shall be calculated. The production item average loss rate for the 72 hour test period shall be corrected from the average temperature experienced during the test period to the average temperature at which the comparative data specified in 4.6.8.1.4 was obtained and the result reported as the pounds of liquid oxygen vaporized per 24 hour day. The tank shall pass the requirements specified in 3.8.7.2.

4.6.9 Pressure build-up.

4.6.9.1 Build-up with low liquid level. The liquid storage tank assembly shall be filled with enough liquid oxygen or liquid nitrogen to insure that a maximum of 3 gallons remains in the inner shell after the specified stabilization. The tank shall then be set with the inner shell vapor space vented to atmospheric pressure for not less than 4 hours. Following this stabilization period, the inner shell vapor vent and fill line shall be closed and the pressure build-up valve opened. The tank shall pass the requirements specified in 3.8.8.1.

4.6.9.2 Transfer tank pressure build-up. The transfer tank shall be filled with liquid oxygen or liquid nitrogen and the pressure build-up system actuated. The length of time required after closing of the transfer vent and fill valves until the vapor phase pressure has reached 90 psig shall be recorded on the data sheets and shall pass the requirements specified in 3.8.8.2.

4.6.10 Insulation combustibility. A sample of the insulation material used in the annular space shall be tested for combustibility as follows:

- a. Place approximately 0.5 gram of the material in an oxygen bomb .
- b. Pressurize the oxygen bomb to not less than 10 psig with oxygen gas having a purity of 99.5 percent or better.
- c. Raise the temperature of the oxygen bomb to not less than 400 F and hold at that temperature for not less than 1 hour.

The insulation shall pass the requirements specified in 3.8.9.

4.6.11 Liquid transfer test.

4.6.11.1 Fill-drain line test. Liquid oxygen shall be transferred into the tank through the fill-drain line at not less than 10 gpm for a length of time adequate to determine the pressure drop resulting from friction losses in the filter and line. Liquid nitrogen may be used at a flow rate which shall provide a pressure drop equivalent to that resulting from the specified liquid oxygen. The fill-drain line pressure drop shall pass the requirements specified in 3.8.10.1.

4.6.11.2 Converter servicing time. The time required to fill a 10 liter liquid oxygen converter to its specified capacity by the transfer tank through the filler valve shall be determined. The converter shall be initially at room temperature. The filling time shall pass the requirements specified in 3.8.10.2.

4.6.11.3 Vent line test. The tank shall be parked under conditions that will insure all liquid storage tank assembly components attaining a temperature of not less than 125°F. After the liquid storage tank components have stabilized at this temperature, liquid oxygen or liquid nitrogen shall be transferred into the inner shell through the fill line until the inner shell has cooled sufficiently to permit filling at the 10 gpm rate. The rate of transfer during cool-down shall be the maximum that will maintain a liquid storage tank assembly inner shell pressure of less than 15 psig. Cool-down time shall be recorded. The inner shell vapor phase pressure shall be recorded. The tank shall pass the requirements specified in 3.8.10.3.

4.6.11.4 Vapor relief capacity. Following the vapor vent line test and with the tank remaining filled to not less than 90 percent of design capacity, the vapor vent line shut-off valve shall be tightly closed, the pressure build-up system control adjusted for maximum build-up rate and all other valves closed. The inner shell vapor space excess pressure shall be permitted to vent through the relief device until the inner shell vapor space pressure reaches its maximum reading. The tank shall pass the requirements specified in 3.8.10.4.

4.6.12 Filter test.

4.6.12.1 Absolute rating. Compliance with the 40 micron absolute rating requirement shall be substantiated by the bubble point method as follows: The filter element shall be submerged in SOLOX 190, or equivalent, fluid. The fluid level shall be maintained at not to exceed 1/2 inch above the top of the element. The element shall be slowly pressurized from within with air or nitrogen gas and slowly rotated 360 degrees at each pressure increment increase. The pressure shall be increased until the bubble point is determined. The filter shall pass the requirements specified in 3.8.11.1

4.6.12.2 Nominal rating. (compliance with the removal of 98 percent by weight of all particles whose smallest dimension is 10 microns or greater shall be substantiated as follows: Following completion of the 50 cycle servicing test, the filter shall be permitted to stabilize at 125°F without any intervening servicing, cleaning, adjustment, or repair. Approximately 10 liters per inch of filter nominal diameter or liquid oxygen or nitrogen previously filtered through a 5 micron Millipore, or equivalent, membrane filter shall be contaminated with not less than 10 grams of particles with the following size distribution:

<u>Size of particle (microns)</u>	<u>Percentage by weight</u>
10 to 20	36 \pm 3
20 to 40	24 \pm 3
40 to 60	16 \pm 3
Over 60	24 \pm 3

The liquid shall be placed in a container, agitated to insure a homogeneous mixture and then transferred through the filter in a time interval of not more than 45 seconds. The filter shall be so positioned that the flow is vertically down and the discharge is directed into a clean, particle free, container with provisions to insure positive retention of any particles passing through the filter and exclusion of external particles. The liquid shall be permitted to vaporize and the container flushed by use of a wash bottle containing approximately 200 ml of isopropyl alcohol which has been previously filtered through a 5 micron Millipore, or equivalent, membrane filter. The wash solution shall then be filtered through a pre-weighed 5 micron Millipore, or equivalent, membrane filter. This container wash procedure shall be performed four times with the wash solution each time, being filtered through the membrane filter. The filter funnel shall also be washed with an additional 200 ml of solvent and this wash solution also passed through the membrane filter. Upon completion of the filtering, the membrane filter shall be dried and weighed again. The filter shall pass the requirements specified in 3.8.11.2.

4.6.12.3 Filter pressure drop. Liquid oxygen shall be transferred through the filter at a flow rate of not less than 10 gpm for a length of time adequate to determine the pressure drop through the filter after contamination. The liquid oxygen stream shall be contaminated with not less than 5 grams of particles of the size and composition specified in 4.6.12.2. The 5 grams of contaminant shall be introduced into the liquid stream at a rate of approximately 1 gram per minute. Introduction of the contaminant shall not require more than 4-1/2 minutes \pm 30 seconds. The pressure drop after the filter has been so contaminated shall be recorded. The filter shall then be further contaminated with particles until a constant pressure drop of not less than 50 psig across the filter element is reached. Following this, the filter shall be opened and inspected. The filter shall pass the requirements specified in 3.8.11.3.

4.6. 12.3.1 Alternate test material. Water may be used at a flow rate which will provide a pressure drop equivalent to that resulting from the specified liquid oxygen flow. If water is employed for this purpose, data shall be provided to substantiate the flow rate used.

4.6.13 Shut-off and control valve test. The valve shall be subjected to the following tests in the order specified:

4.6.13.1 Globe valve cycling test. The globe valve shall be closed with a torque of 60 ± 5 lb-in. per inch of nominal size and subjected to a compressed air, oxygen gas or nitrogen gas inlet pressure of not less than 50 psig with the outlet open to atmospheric pressure. The valve shall then be opened to not less than the three-fourths open position, after which it shall be again closed with a torque of 60 ± 5 lb-in. per inch of nominal size and the specified inlet pressure reestablished. This shall constitute 1 cycle. One thousand such cycles shall be accomplished without intervening valve lubrication, adjustment, or repair while the valve body is subjected to ambient temperature. The thousand cycle test shall then be repeated with the valve body submerged in liquid oxygen or liquid nitrogen. The globe valve shall pass the requirements specified in 3.8.12.

4.6.13.2 Globe valve overtorque test. At the conclusion of the cycling test specified in 4.6.13.1, the globe valve shall be removed from the liquid bath and permitted to stabilize at ambient temperature. The valve shall then, without intervening lubrication, adjustment, or repair, be fully opened and closed with a torque of 300 ± 10 lb-in. per inch of nominal size. The globe valve shall pass the requirements specified in 3.8.12.

4.6.13.3 Leakage. Following the overtorque test specified in 4.6.13.2 and without intervening valve lubrication, adjustment, or repair, the valve shall be fully opened and closed with a torque of 60 ± 5 lb-in. per inch of nominal size. The valve shall then be completely immersed in clear water with the inlet subjected to a compressed air, oxygen gas, or nitrogen gas pressure of not less than 50 psig for not less than 10 minutes with the outlet open. Any leakage past the seat, through the packing, or through the valve body shall be collected and measured. The globe valve shall pass the requirements specified in 3.8.12.

4.6.13.4 Toggle valve cycling test. The valve shall be closed and then subjected to a compressed air, oxygen or nitrogen gas inlet pressure of 100 psig with the outlet open to the atmosphere. The valve shall then be completely opened and then closed. This shall constitute 1 cycle. One thousand such cycles shall be accomplished without intervening valve lubrication, adjustment, or repair while the valve body is subjected to ambient temperature. The thousand cycle test shall then be repeated with the valve body submerged in liquid oxygen or liquid nitrogen. The valve shall pass the requirements specified in 3.8.12.

4.6.13.5 Toggle valve leakage test. Following the cycling test specified in 4.6.13.4 and without intervening valve lubrication, adjustment or repair, the valve shall be fully opened and closed with a torque of 120 ± 10 lb-in. per inch of nominal size. With the valve body at either ambient temperature or the atmospheric pressure boiling temperature of liquid oxygen or nitrogen, the valve inlet shall be subjected to a pressure of 100 psig with the valve outlet open to the atmosphere. The valve shall pass the requirements specified in 3.8.12.

4.6.14 Disconnect coupling torque resistance test. The liquid fill-drain line disconnect coupling and the servicing line disconnect fitting shall be subjected to a torque of not less than 300 lb-ft per inch of nominal line size applied to the coupling in one and then in the other direction of rotation with a 24 inch wrench. The coupling shall pass the requirements specified in 3.8.13.

4.6.15 Servicing and maintenance test. All normal preventive maintenance and servicing operations specified in the maintenance and instruction handbook shall be performed to determine their adequacy, ease of accomplishment and the accessibility of parts and assemblies for performance of same, unless such instructions are contrary to those necessary for compliance with the requirements specified herein. Insofar as practicable, this test shall be conducted as part of the normal preventive maintenance, servicing and inspection performed in accomplishing the testing specified herein. The tank shall pass the requirements specified in 3.8.14.

4.6.16 Mobility test. The unit shall be subjected to the general tests of MIL-M-8090 and to those specified for type II mobility items (see 6.2). In addition, compliance with the weight distribution requirements shall be verified. The adequacy of the stop shall be verified by raising the tow bar of a filled tank until the center-of-gravity acts to continue upward movement of the tow bar until the stop contacts dry hardened concrete. No restraining force shall be applied to limit the impact of the contact. After each test, the tank shall be inspected for misalignment, distortion and defects. The tank shall pass the requirements specified in 3.8.15.

4.6.17 Environmental tests. The tank shall be subjected to the following tests conducted in accordance with the applicable specified methods of MIL-STD-810. At the conclusion of each test, the tank shall be examined for deterioration.

4.6.17.1 Low temperature exposure test. The liquid storage tank assembly shall be filled to design capacity with liquid oxygen or liquid nitrogen and the tank subjected to low temperature in accordance with method 502, procedure I of MIL-STD-810.

4.6.17.2 High temperature test. The liquid storage tank assembly shall be filled to design capacity with liquid oxygen or liquid nitrogen and the assembly subjected high temperature testing in accordance with MIL-STD-810, method 501.1, procedure I. The control housing access doors shall be open throughout this exposure, The tank shall pass the requirements specified in 3.8.16.

4.6.17.3 Humidity test. The complete tank shall be subjected to a humidity test in accordance with MIL-STD-810, method 507.1, procedure 11. The tank shall pass the requirements specified in 3.8.16.

4.6.17.4 Salt-fog test. The complete tank shall be subjected to a salt-fog test in accordance with MIL-STD-810, method 509. The tank shall pass the requirements specified in 3.8.16.

4.6.17.5 Rain test. The complete tank shall be subjected to a rain test in accordance with MIL-STD-810, method 506.1, procedure I. The tank shall pass the requirements specified in 3.8.16.

4.6.17.6 Dust test. The complete tank shall be subjected to a sand and dust test in accordance with MIL-STD-810, method 510.1, procedure I. The tank shall pass the requirements specified in 3.8.16.

4.6.17.7 Wind test. It shall be demonstrated by testing or calculations that the tank will withstand a 70 mph wind. The tank shall pass the requirements specified in 3.8.16.

4.6.18 Servicing test. The tank shall be filled to capacity with liquid oxygen or liquid nitrogen and permitted to set with the vent valve wide open until all uninsulated external components of the outer shell have warmed to approximately ambient temperature. The tank shall then be subjected to the following testing:

4.6.18.1 Following the filling and stabilization specified above, a servicing cycle shall be performed on an empty converter in the order listed.

- a. Open transfer tank fill and vent valves and fill transfer tank. When full close the fill and vent valves.
- b. Place an aircraft converter on the servicing table and connect the tank vent return line to the aircraft converter vent.
- c. Connect the aircraft filler valve, CRU-59/E, to the converter which actuates the filler valve control.
- d. After recovering the vapor from the converter into the transfer tank, open the pressure build-up valve and pressurize to 90 psig.

- e. Open the valve in the vent return line which allows the liquid to be transferred into the converter.
- f. Close the pressure build-up valve and the valve on the vent return line after the converter is full (as indicated by the converter full device).

4.6.18.2 The servicing cycle specified in 4.6.18.1 shall be repeated until the storage tank has been subjected to not less than fifty such cycles.

4.6.19 Mechanical check. Upon completion of the above tests, a critical inspection shall be made of components to determine their operability and any damage or undue wear incurred during the tests. Tear-down and parts measurement shall be made only in those cases where service life is in question. Where tear-down and parts measurements are performed, wear or distortion that exceeds limits permitted by the manufacturer for new parts shall be cause for considering the part or parts affected as having failed to complete the test satisfactorily.

4.6.19.1 Steel parts subject to high stress in operation and that are suspected of having defects shall also be subjected to magnetic particle inspection and shall exhibit no indications of damage attributable to the tests, or shall be considered as having failed the test. Grinding checks and sub-surface indications of laps or seams shall not be cause for rejection. Magnetic particle inspection shall be performed in accordance with MIL-I-6868.

4.6.19.2 Nonmagnetic parts suspected of defects shall be subjected to inspection with fluorescent penetrant (black light) and shall exhibit no breaks or other defects that would impair their life or usefulness. Penetrant inspection shall be performed in accordance with MIL-I-6866.

4.6.20 Reliability demonstration. Satisfactory completion of all tests specified herein with no failure preventing satisfactory performance shall be considered as demonstrating compliance with the quantitative reliability requirement. Any test resulting in a failure shall be documented. Apparent failures that are caused by some unintended factor external to the equipment (for example, test equipment failure) need not be counted as reliability failures if the cause can be substantiated to procuring activity satisfaction. Acceptance for reliability purposes shall not be made until, to the satisfaction of the procuring activity, each failure has been analyzed, the cause determined, design or other modifications made to preclude repetition of the failure or related failures, successful retest made by the contractor of the failed equipment with the modifications included, and contractor action taken to reflect the modifications in equipments to be delivered. In addition to a particular failed test, any retest shall include all tests that could be influenced by the modifications.

4.6.21 Maintainability demonstration. Compliance with maintainability requirements shall be demonstrated by task performances as specified below. The active maintenance down-times, the tools and equipment required, and any obstructions or conditions hindering the task or presenting potential hazards to personnel or to parts shall be observed and recorded. Signs of excessive wear or other indications of potential failure shall be recorded where observed and the information supplied to the design activity for study and for recommendation of any appropriate corrections to be reflected in future items delivered. Such recommendations shall be subject to procuring activity approval before being implemented, or successful repeat of other test specified herein may be required where the test result could be influenced by the correction. It shall be demonstrated that the item is in satisfactory operating condition after the maintenance tasks have been done. Maintenance task time data from maintenance and tear-down inspection made in connection with other specified demonstrations may be applied to the maintainability demonstration if adequate observations are made and recorded.

4.6.21.1 Corrective maintenance. Compliance with quantitative corrective maintenance down-time requirements shall be demonstrated by a maintenance demonstrative procedure, maintenance task selection, and maintenance task performances in accordance with MIL-STD-471 including appendix A and appendix B, method 1, test plan pair (A1 plus B1).

4.6.21.2 Preventive maintenance. Compliance with the quantitative preventive maintenance down-time requirements shall be demonstrated in accordance with MIL-STD-471, appendix B, method 6. Each task need not be done more than once. For maximum preventive maintenance down-time demonstration, less than 0.1 (10 percent) of the task times observed shall require greater down-time than the quantitative requirement.

4.6.22 Bursting disc. The bursting disc shall be subjected to a gradually increasing pressure until the bursting disc ruptures. The bursting disc shall pass the requirements specified in 3.8.21.

5. PACKAGING

5.1 Preparation for shipment.

5.1.1 A type A tag conforming to UU-T-81, with tag and printing water-proofed, stating that liquid storage tank assembly inner shell is cleaned and pressurized with clean, dry, oil-free nitrogen gas and indicating the data and the pressure to which the annular insulation space has been evacuated, shall be securely attached to the vapor vent line shut-off valve handle in a conspicuous location.

5.1.2 Preservatives. Preservatives and lubricants shall not be applied to any part of the equipment that will come into contact with high-purity oxygen.

5.1.3 Securing for shipment. Small items and packages not fastened to or a part of major components shall be secured to or packed with major components to insure against accidental loss or damage during shipping.

5.2 Preservation and packaging. Preservation and packaging shall be level A or C, as specified by the procuring activity (see 6.2).

5.2.1 Level A. Unless otherwise specified, the liquid storage tank shall be physically and mechanically protected in accordance with method III of MIL-P-116. Unit quantities shall be one each.

5.2.2 Level C. The liquid storage tank shall be preserved and packaged in accordance with the manufacturer's commercial practice.

5.3 Packing. Packing shall be level A, B or C, as specified by the procuring activity (see 6.2).

5.3.1 Levels A and B. Unless otherwise specified, the liquid storage tank shall be provided with a wooden shield constructed to provide protection for the instruments and controls while the tank is in transit or storage. The shield shall enclose the entire instrument and control area and shall be securely fastened to the tank. Exterior shipping containers will not be required.

5.3.2 Level C. Liquid storage tanks that require over-packing for acceptance by the carrier shall be packed in a manner that will insure safe transportation at the lowest rate, to the point of delivery. Containers shall conform to the Uniform Freight Classification rules or regulations of other carriers as applicable to the mode of transportation.

5.4 Physical protection. Cushioning, blocking, bracing, and bolting, as required, shall be in accordance with MIL-STD-1186, except that for domestic shipments, waterproofing requirements for cushioning materials and containers shall be waived.

5.5 Shipment marking. Tanks shall be marked for shipment in accordance with MIL-STD-129. The nomenclature shall be as follows:

TANK, STORAGE, LIQUID OXYGEN,
LOW LOSS CLOSED CYCLE,
TMU-70/M

6. NOTES

6.1 Intended use. The TMU-70/M tank is intended for use in servicing aircraft liquid breathing oxygen systems and any other application where aviator's liquid breathing oxygen is used. The unit can be air-lifted when filled to capacity and placed in use immediately upon arrival.

6.2 ordering data. Procurement documents should specify the following:

- a. Title, number, and date of this specification.
- b. When a complete set of all special tools, other than common hand-tools and those normally available in motor vehicle repair shops, is to be provided (see 3.7.11).
- c. Registration number required (see 3.13.5).
- d. Whether first article test plan is required (see 4.3.1).
- e. Whether first article inspection is required and where first article testing is to be performed (see 4.3.2).
- f. Selection of applicable levels of preservation, packaging, and packing (see 5.2 and 5.3).
- g. Applicable methods of cleaning and preservation.
- h. Items of data required (see 6.4).

6.3 Definitions. For the purpose of this specification, the following definitions will apply:

6.3.1 Failure. For reliability purposes, a failure is defined as any failure or malfunction that could prevent satisfactory (within specified limits) and safe operation in the primary functions or receiving, storing, transporting and dispensing the specified liquid.

6.3.2 Fibrous particle. A fibrous particle is defined as a long, slender particle whose maximum cross-sectional dimension is 40 microns.

6.3.3 Ambient conditions. Ambient conditions are the dry-bulb temperature, wet-bulb temperature and the relative humidity of the atmospheric air surrounding and in the vicinity of the tank, but unaffected by any heat or cold emanating from the tank itself.

6.3.4 Valve cycle of operation. A cycle of operation for a valve is defined as opening the valve from sealing a differential pressure of not less than 50 psig to the not less than three-fourths open position, and reclosing the valve with a torque of 60 ± 5 lb-in. per inch of valve nominal size.

6.3.5 Pressures. All pressures referred to herein, unless specified as absolute, denoted by the symbol psia, will be interpreted as pounds per square inch gage (psig).

6.3.6 Dissimilar metal vacuum joint. A dissimilar metal vacuum joint is a mechanical (welded or other type) joint between different base metals, or between alloys with different base metals as the principal constituent, used in the tank construction where the joint must function to seal the liquid storage tank assembly annular insulation space from a different Pressure.

6.4 Contract data requirements. When this specification is used in a procurement which incorporates a DD Form 1423 and invokes the provisions of 7-104.9(n) of the Defense Acquisition Regulations, the data requirements identified below will be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (DD Form 1423) incorporated into the contract. When the provisions of DAR-7-104.9(n) are not invoked, the data specified below will be delivered by the contractor in accordance with the contract requirements. Deliverable data required by this specification is cited in the following paragraphs:

<u>Paragraph</u>	<u>Data requirement</u>	<u>Applicable DID</u>
4.3.1	First article test plan	DI-T-5315 - first article qualification test plan
4.3.2.1	First article inspection reports	DI-T-5329 - inspection test reports

6.5 First article. When a first article is required, it shall be tested under the appropriate provision of 7-104.55 of the Data Acquisition Regulation. The first article should be a preproduction sample. The contracting officer should include specific instructions for examinations, tests and approval of the first article.

6.6 Patent information. Attention is invited that a royalty free license has apparently not been granted the Government for the following system:

<u>System</u>	<u>Patent number</u>	<u>Issue date</u>
Low-loss closed-loop supply system for transferring liquified gas from a large container to a small container	3,710,584	16 Jan 1973

Preparing Activity
Navy (AS)
(Project No. 3655-N092)

TABLE I. Separation of valve packing gland from valve connection centerline.

Valve nominal size (in inches)	Separation of packing gland from connection centerline (in inches)
1/4	4
3/8	4
1/2	7
3/4	7
1	9
1-1/4	9
1-1/2	11
2	11
2-1/2	12
3	12

TABLE II. Sample size, acceptance criteria, tests, and examinations of the tanks.

Inspection	Method	Sample size	Acceptance criteria
Visual examination (see classification of defects)	4.6.1.1	Every tank for critical defects. Inspection Level II for minor defects.	Reject all units with any critical defect. An acceptable quality level of 2.5 defects per hundred units for minor defects
Dimensions	4.6.1.1.1	Inspection Level S-2 <u>1</u> /	Acceptance number zero, rejection number 1
Spring loaded relief valve test	4.6.2	Every relief valve	Reject all defective units
Pressure test	4.6.3	Every tank	Reject all defective units
Cleanliness test	4.6.4 through 4.6.4.2	Every tank	Reject all defective units
Heat leak	4.6.8.2 and 4.6.8.2.1	Every tank	Reject all defective units

TABLE II. Sample size, acceptance criteria, tests, and examinations of the tanks. - Continued.

Inspection	Method	Sample size	Acceptance criteria
Bursting disc	4.6.22	Inspection Level S-2 <u>1/</u>	Acceptance number zero, rejection number 1 <u>2/</u>
Shut off and control valve tests	4.6.13 through 4.6.13.5	One of each type from each lot of 100 or less	Acceptance number zero, rejection number 1 <u>3/</u>
Filter tests	4.6.12 through 4.6.12.3.1	One from each lot of 80 or less	Acceptance number zero, rejection number 1 <u>4/</u>
Dissimilar metal vacuum joint test	4.6.6.2.1	One of each size, style and construction from each lot of 25 or less	Acceptance number zero, rejection number 1 <u>5/</u>
Packaging	4.6.1.2	Inspection Level S-2	Total acceptable quality level of 4.0 percent defective

1/ The sample size shall be based only on the applicable sample size code letter corresponding to the specified inspection level of MIL-STD-105.

2/ If a disc fails at a pressure outside the limits established by the tank manufacturer for compliance with the specification, five additional sample bursting discs from the same lot shall be tested in the same manner. If more than one of the original samples or any of the five additional sample rupture discs fail at pressure outside the specified limits, the entire lot shall be rejected.

If the valve fails to fulfill all specified requirements, three additional samples from the lot shall be tested in the same manner. If any of the three additional sample valves fail to fulfill all specified test requirements, the entire lot shall be rejected.

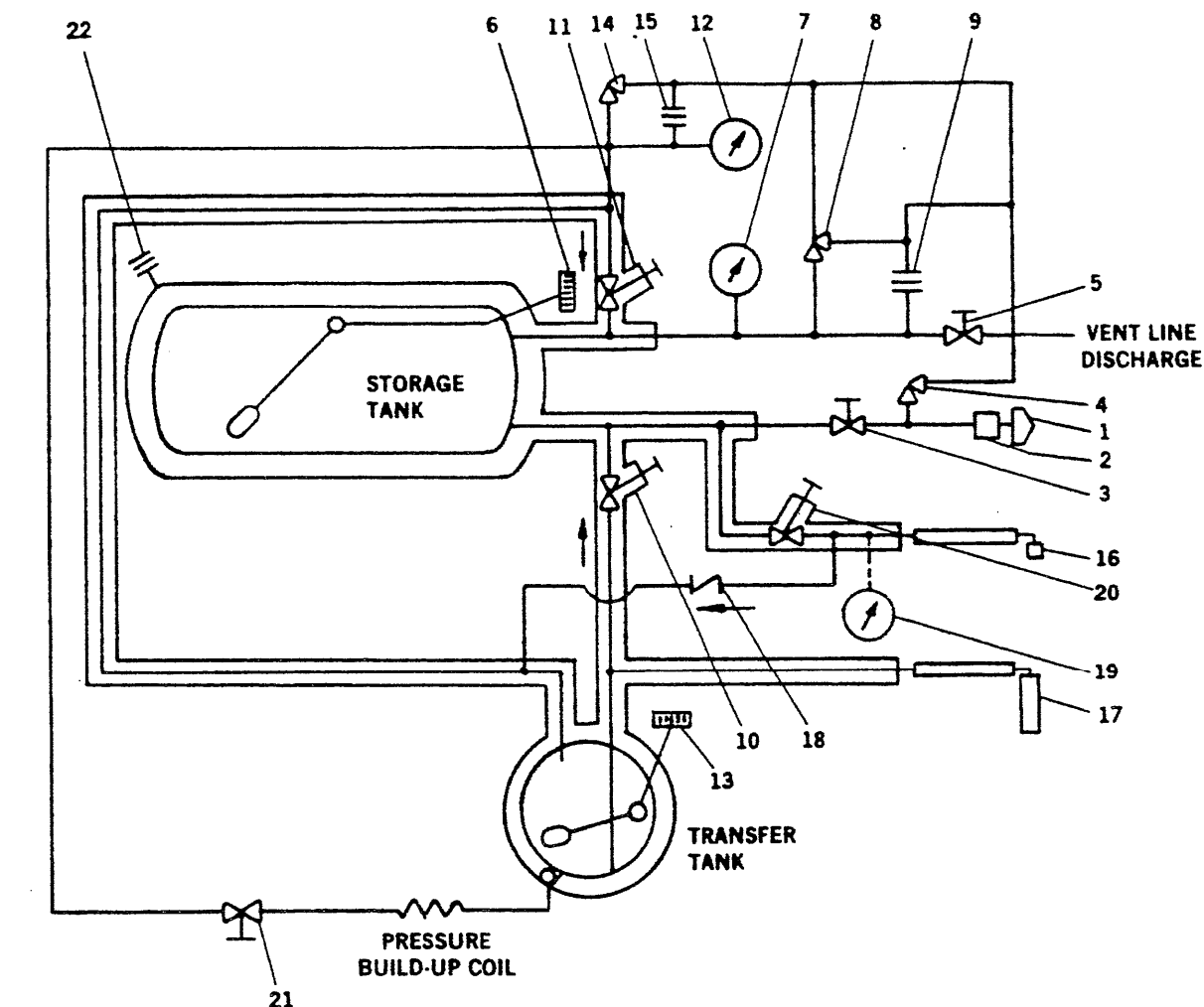
- 4/ If a filter fails to fulfill all specified test requirements, two additional sample filters from the lot shall be tested in the same manner. If either of the two additional sample filters fail to fulfill all specified test requirements, the entire lot shall be rejected.
- 5/ If the joint fails to fulfill all specified requirements, three additional samples from the lot shall be tested in the same manner. If any of the three additional sample joints fail to fulfill all specified test requirements, the entire lot shall be rejected.

TABLE III. Classification of defects for visual examination of the tanks.

Critical	Minor
1. Material imperfections - foreign matter embedded.	201. Marking - missing, insufficient, incorrect, illegible, or not permanent.
2. Surface - unclean, rough, misaligned, or containing cracks, nicks, or other flaws.	202. Color not as specified.
3. Any component misaligned or not readily adjustable.	203. Red tag missing.
4. Weight not as specified.	
5. Any component missing, malformed, fractured, or otherwise damaged.	
6. Any component loose or otherwise not securely retained.	
7. Incorrect assembling or improper positioning of components.	
8. Any functioning part that works with difficulty.	
9. Faulty workmanship or other irregularities.	

TABLE IV. List of defects for packaging.

Item	Defects
Exterior markings	Missing, incorrect, incomplete, illegible; improper size, location, sequence, or method of application.
Packaging and packing materials	Any non-conforming component; any component missing, damaged, or otherwise defective.
Workmanship	Inadequate application of the components such as incomplete unit package, loose strapping, etc.; bulging or distortion of the containers.
Content	Number per container is more than required.



- | | |
|--|---|
| 1. Fill-drain line coupling | 12. Transfer tank pressure gage |
| 2. Fill-drain filter | 13. Transfer tank liquid level gage |
| 3. Fill-drain line shut-off valve | 14. Transfer tank inner shell relief valve |
| 4. Fill-drain relief valve | 15. Transfer tank inner shell rupture disc |
| 5. Storage tank vent line shut-off | 16. Converter vent line connector |
| 6. Storage tank liquid level gage | 17. Filler valve |
| 7. Storage tank pressure gage | 18. Converter vent line check valve |
| 8. Storage tank inner shell relief valve | 19. Converter full indicator gage |
| 9. Storage tank inner shell rupture disc | 20. Converter vent line shut-off valve |
| 10. Transfer tank fill line shut-off valve | 21. Transfer tank pressure build-up valve |
| 11. Transfer tank vent line shut-off valve | 22. Outer shell relief device and vacuum pump-out |

FIGURE 1. Liquid oxygen storage tank schematic diagram.

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<p>DOCUMENT IDENTIFIER (Number) AND TITLE</p> <p>MIL-T-85418(AS) TANK, STORAGE, LIQUID OXYGEN, LOW LOSS CLOSED CYCLE, TMU-70/M</p>	
<p>NAME OF ORGANIZATION AND ADDRESS OF SUBMITTER</p> <p> </p>	
<p> <input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER </p>	
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